THE
ELECTRICAL REVIEW.

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"ELECTRICAL REVIEW."

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THE MYSTERY OF RADIO-ACTIVITY.

SINCE Becquerel discovered that uranium and its compounds gave off continuously some form of radiation capable of making an impression on a photographic plate, and deviable by a magnetic field, a great deal of attention has been devoted by physicists to the study of the radio-activity of matter, and new and much more intensely radio-active substances have been discovered. It has been shown that temporary radio-activity can be communicated to bodies in which the property is not inherent, and that this excited radio-activity is very widely spread in nature, a circumstance which may yet lead to the explanation of many of the hitherto inexplicable phenomena of atmospheric electricity.

The explanation of radio-active phenomena is intimately connected with the new electron theory. At first, indeed, it was supposed that the Becquerel rays were simply a spontaneous discharge of negative electrons from the radio-active substance, and, consequently, that they were identical with cathode rays. But further investigation has shown that their composition is by no means so simple as this hypothesis would imply. Cathode rays consist of a stream of negatively charged particles, or electrons, of very much smaller mass than the smallest atom, and the cathode rays, as this theory would lead us to expect, are easily deflected by a transverse magnetic field. Now it has been found that only a part of the radiation from uranium is deviable by a magnetic field, so we are forced to the conclusion that there is something more in these rays than a stream of negative electrons.

The presence of cathode rays among the Becquerel rays would lead us to predict that Röntgen rays would be found to be a constituent of the non-deviable rays emitted by radio-active bodies. The usual method of producing Röntgen rays is by the impact of cathode rays upon the matter of the anti-cathode. The electrons discharged by the radio-active bodies are not likely to get clear without a considerable amount of collision with the atoms through which they pass to the surface. These collisions would give rise to Röntgen rays. Now Röntgen rays are characterised by their non-deviability in the magnetic field, and by their great penetrating power, and Sir William Crookes, in a paper read before the Royal Society on March 19th, has, by means of these characteristics, demonstrated their presence in the radiation from radium, the most powerful of all known radio-active substances. When a platinum wire dipped in nitrate of radium was brought near a platino-cyanide of barium screen, scintillations or splashes of light were observed when the screen was examined by a microscope. Sir William Crookes attributes these scintillations to the impact of electrons discharged from the radium. There was also on the screen a general luminosity which undoubtedly was due to Röntgen rays, because when mica or aluminium foil was interposed the scintillations were arrested, but the general luminosity on the screen was not affected.

D

It remains to be considered whether there is any other constituent present in Becquerel rays, in addition to cathode rays and Röntgen rays. Of the presence of one other constituent, undoubted proof has been given by Mr. E. Rutherford and others. The following is Rutherford's analysis of the radiation emitted by radium (*Phil. Mag.*, Vol. v., p. 177, February, 1903):—(α) rays (non-deviable) with a penetrating power represented by ·0005 cm. of aluminium; (β) rays (deviable) with penetrating power equal to ·05 cm. of aluminium; (γ) rays (non-deviable) with penetrating power equal to 8 cm. of aluminium. The (β) rays are cathode rays, and the (γ) rays are Röntgen rays, but what are the (α) rays? Though the (α) rays are not deviable with magnetic fields of moderate strength, Rutherford has succeeded with a very powerful magnetic field in effecting a measurable deviation. The deviation, however, is in the opposite direction to the deviation of the (β) rays, showing that the electric charge of the particles in the (α) rays must be positive. The small amount of the deviation of the (α) rays also points to the conclusion that their mass is much greater than the mass of the particles in the (β) rays. The ratio of their mass m, to their electric charge e, has been calculated by Rutherford as being approximately $\frac{m}{e} = \frac{1}{6 \times 10^3}$. Now $\frac{m}{e}$ for the hydrogen atom is about $\frac{1}{10^4}$, but for the electron it is about $\frac{1}{10^7}$. Everything, therefore, points to the conclusion that the (α) rays consist of a stream of atoms with a positive electric charge. This may be termed the positive ion, as it corresponds to the part of the molecule which travels towards the cathode in electrolysis, or it may be termed the positive electron, as it corresponds to the positive atom which combines with a negative electron to form a neutral or nearly neutral combination. The larger size of the particles in the (α) rays gives a satisfactory explanation of their low penetrating power. They cannot pass through between the atoms, even of a gas, without a much greater chance of collision than the relatively much smaller negative electrons.

One of the most remarkable properties of Becquerel rays, a property which they share with cathode rays and Röntgen rays, is the power of dissociating or ionising the molecules of a gas and thereby increasing its conductivity. It is by means of this property that the exact quantitive analysis of Becquerel radiation has been carried out. The strength of the radiation is measured by the number of molecules which it dissociates, and as an electric current is only possible where the elements of a dissociated molecule are present to act as carriers, the number of the dissociated elements can be very exactly measured by a sensitive electric current meter. The most suitable instrument has been found to be the quadrant electrometer, and the current is measured by noting the speed at which the needle moves as the instrument is charged. Rutherford considers that, in the case of the Becquerel rays, by far the greatest part of the ionisation of the surrounding gas is effected by the (α) rays, *i.e.*, by the positively charged atoms, positive electrons, or whatever they may be called. The (α) rays appear to be identical with the *Canal Strahlen*, of Goldstein.

This analysis of the Becquerel radiation into three distinct kinds of rays which can be identified with forms of radiation already known, does not, however, bring us to the end of the mystery of radio-activity. Rutherford (*Phil. Mag.*, 1900, pp. 1 and 161) discovered that in addition to a straight line radiation, compounds of thorium gave off an emanation which behaved like a neutral gas, but was itself radio-active, and had the power of exciting temporary radio-activity in all surrounding bodies with which it came in contact. This emanation could be passed through white hot tubes, bubbled through acids, or filtered through cotton wool without loosing any of its remarkable properties. Curie showed, shortly after, that radium gave out a similar emanation. Polonium and uranium, however, give out no emanation. If one of the bodies surrounding the emanation has a negative electric charge, the whole of the excited radio-activity will be confined to its surface. This experiment suggests that the emanation may consist of positive ions or electrons. This hypothesis, however, is upset by the fact that the emanation of radium persists for weeks, though exposed to a strong electric field. The emanation appears to act by withdrawing negative electrons from the molecules of air, and thus leaving positive oxygen electrons which are drawn by the electric field on to the negatively-electrified surface. A layer of positive electrons on a surface attracts and projects negative electrons from beneath the charged surface, and thus excites a radio-activity consisting of (β) rays.

Elster and Geitel have shown that if a wire is maintained at a high negative potential for several hours, it becomes temporarily radioactive. Here again the attraction of the negative charge on the wire has led to the formation of a coating on the wire of positive electrons attracted from the surrounding atmosphere. Now, it has long been known that the earth has a strong negative charge of electricity, and we should consequently expect to find that the surface of the earth is radio-active, and also that the radio-activity would be strongest where the negative potential gradient is steepest—*i.e.*, over projections and points on the earth's surface. Experiment has already demonstrated the truth of this surmise. In mountainous regions the radioactivity has been found to be greater than in the plains; the points of lightning rods and leaves of trees have also been found to be strongly radioactive. Since radioactivity means dissociation and increased conductivity of the air, the important bearing of this discovery on the phenomena of atmospheric electricity is evident.

Whatever the emanation may be, it behaves like a gas whose atoms have no chemical affinity and no electric charge. Rutherford considers that it may be a gas of the argon family, and from its rate of diffusion he has estimated that the atomic weight of the radium emanation lies somewhere between 40 and 100. Now, the atomic weight of radium has been estimated by Curie as 225, and from this we must infer that the emanation must be of an entirely different material from the radium from which it emanates.

There is every reason for believing that radio-active substances have been discharging positive and negative electrons and Röntgen rays into space for ages, and there is no sign of any diminution in the amount of energy which they give out. Physicists, imbued with the doctrine of the conservation of energy, have tried in vain to discover where the radio-active furnace gets its constant supply of fuel. It was long supposed that the quantity of energy given out was so minute that even if the supply of intrinsic energy in the molecules was small, no change would be perceptible except after the lapse of long intervals of time. But some recent experiments by MM. Curie and Laborde (*Comptes Rendus*, March 16th, 1903) have shown that the amount of energy given out by a gramme of radium amounts to as much as 100 gramme-calories per hour. This would be equivalent to raising a 100-lb. weight through a height of 3 ft. per hour, and a gramme atom of radium would develop per hour as much heat as a gramme atom of hydrogen in combining with oxygen. It is hardly conceivable that a constant supply of energy of such magnitude could be kept up without taking in fresh energy from the outside.

Sir William Crookes accounts for the supply of energy by supposing that the radium atom has the power of absorbing the energy of the more rapidly moving particles of the atmosphere, and thus gets over the difficulty by endowing the radio-active atoms with the superhuman powers of Maxwell's "demons." Rutherford thinks the energy is derived from the shrinkage of the atom, much as the energy of volcanic eruptions is derived from the shrinkage of the earth. This would imply a transmutation into some other material, and Curie objects to this that the spectroscope has given no indication of such a change after an interval of several years. Curie himself thinks that radium utilises an external energy of an unknown nature. Evidently we are yet a long way from a complete solution of the mystery of radio-activity.

Secret Commissions.

It is not often that cases involving an inquiry into the gift or receipt of a secret commission come before the Courts for consideration. Cases which relate to conduct of this kind on the part of any member of a great profession are still rarer. But the canker is, unfortunately, deep-seated in our commercial frame, and it is inevitable that the disease must sometimes come to the surface, to the shame of all those who have been fostering its nefarious progress. Considering the opportunities which are afforded in connection with engineering contracts of all kinds, it is satisfactory to find that engineers are scarcely ever accused of accepting bribes; but a recent case in Scotland shows that such things do occur, and that they are attended with lamentable consequences to all parties concerned. In the case of the Leeds Engineering Co. *v.* Scottish Comb Co. (1902, 19 Shf. Ct. R., 54), cross actions were brought by an English engineering firm and an Aberdeen manufacturing company, the former suing for the price of machinery furnished, and the latter for damages in respect of defects, and for the payment of a commission by the English firm to a consulting engineer through whom the Scottish company had conducted the negotiations. This gentleman was professedly acting for the buyers and was paid by them, but he so planned the specifications that there was practically no competition for the work, and it was given to the English firm with whom he had previously arranged a commission. The existence of the second commission was only discovered by the buyers in the course of correspondence regarding the alleged defects. The Sheriff-substitute held that the commission paid by the sellers to the buyers' agent had increased the price to the buyers' injury, and that the buyers were upon this ground entitled to succeed. He also held that inasmuch as fraud, in the legal sense, had entered into the contract, the buyers were not bound by the ordinary rules as to rejection or notice, and that damages might be awarded for defects, although the buyers had kept the whole plant and had used part of it steadily in their business for four or five months. A considerable sum of damages was awarded to the buyers in addition to repayment of the commission paid by the sellers to the buyers' agent. The important point to be noted in relation to this case is that the engineer's wrongful act appears to have vitiated the entire contract, with the result that the company who purchased the machinery were entitled to damages for defects which made themselves apparent only after the lapse of a considerable time. Whether this doctrine would prevail in an English Court we cannot undertake to say; but it is clearly consonant with reason and justice. It would seem that the commission in this case took the form of a monetary payment; but it is obvious that the principles which enabled the Sheriff-substitute to grant redress would apply even if the bribe had assumed a less tangible form.

A NOVEL THEORY OF MAGNETISM.

We are so much in the habit of faithfully following the teaching of the schools in matters of theory, that we often persist in squeezing phenomena into the scholastic mould long after our common sense has suggested to us that they no longer fit. Then comes the original genius who strikes out a new line, shows where the old theory fails, and suggests a new theory which gives a better explanation of the known phenomena. This *rôle* Herr Zacharias endeavours to play for the theory of magnetism, in an interesting and suggestive paper published in the *Verhandlunden des Vereins für Eisenbahnkunde, Berlin.*

Zacharias considers that we have all along been on the wrong tack in supposing that a live solenoid produces a magnetising force, parallel to its axis, which polarises the particles of iron in its core. His view is, that the current in the solenoid creates a reduction of ether pressure in the core, and that magnetic force is entirely an electric pressure phenomenon. There is no such thing as magnetic attraction; an armature is forced against the poles of its magnet by the pressure of the ether on its particles.

As an example in which the ordinary theory fails to give an adequate explanation of the observed phenomena, Zacharias takes the ironclad magnet. According to the ordinary theory, the edge of the tube which surrounds the coil should form one pole of the magnet, the end of the core forming the other pole. When the lines of force are mapped out by filings this is found not to be the case. As may be seen from fig. 1, the majority of the lines of force pass from the end of the core to the middle of the tube. The

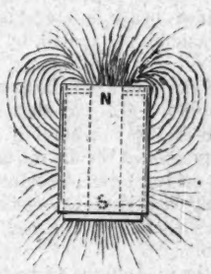


Fig. 1.

present theory of magnetic leakage supposes that the number of lines of force which are to be found on any path is inversely proportional to the resistance of the path. The resistance of the path from the end of the core to the edge of the tube must be very much less than from the end of

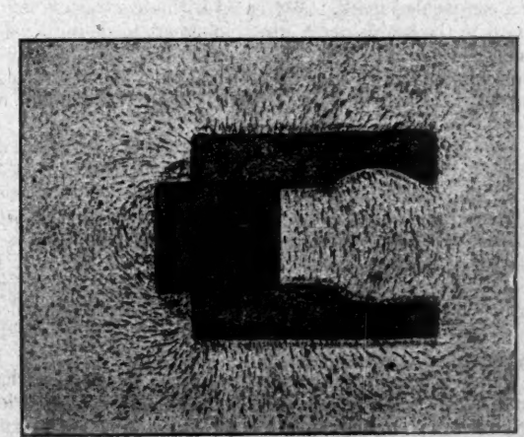


Fig. 2.

the core to the middle of the tube, and yet we find the greater number of lines of force passing along the latter path. Thus the magnetic circuit theory appears to be quite inadequate to explain the actual distribution of lines of force about the ironclad magnet.

Take as another example the field of force about such a magnet as is shown in fig. 2. This magnet, which is often used for dynamos and electromotors, is of horse-shoe shape, with a single magnetising coil on the yoke. The magnetic circuit theory would lead us to expect the strongest field between the poles where the armature would be placed. The distribution of the iron filings shows that this is not the case; the strongest field is at the ends of the magnetising coils, and the lines of force appear to prefer the high resistance path through the air between ends of the magnetising coil, to the low resistance path through the pole-pieces and the short air space between them.

Herr Zacharias's theory is, that every part of the magnetising coil, except where a field of force is required, should be covered with iron, which acts as a screen to prevent dissipation of the vacuum inside the core. This leads to a rule for the design and construction of magnets, which is quite opposed to that deduced from the ordinary magnetic circuit theory.

Herr Zacharias's theory requires a much fuller exposition than is given in the paper cited, before a final judgment can be given as to its validity, but there are so many anomalies in the behaviour of magnets which the present theories do not explain, that any plausible new explanation deserves attention.

THE "1903" REVISED RULES OF THE I.E.E.

(*Continued from page* 598.)

Conductors—Joints.—Rule 35 prohibits joints, except on sub-circuits as defined by Rule 3, and it is laid down that larger conductors should be jointed by means of junction boxes. In describing how these should be constructed no mention is made of the material to be used for mounting the connections, although we are told that special precautions must be adopted to exclude moisture in damp places. But moisture is always present in the air in this country, and will readily condense on cold surfaces like china. We think it will be found that china connection bases are sources of leakage unless the whole is shellaced or the box filled with paraffin wax.

Rule 37 relates the precautions to be taken when jointing cables insulated with hygroscopic dielectrics—in fact, we notice that this method of insulation is fully recognised throughout the rules, and provisions made for its use. We are glad to see that Rule 38 prohibits the use of joints between flexible cords and permanent wires under flooring and in wood casing, a too frequent source of danger in connecting electroliers and brackets. It is also recommended that joints should be accessible, and their positions indicated by a conspicuous mark. Most good wiring contractors leave screws in the boards under which joints are made to fittings, but it is a pity that it is not suggested that no installation shall be considered finished until a plan of the wiring, showing all boxes and runs, be left with the landlord or tenant.

Buried Conductors in Buildings.—Rule 39, which deals with conductors buried in plaster or cement, makes it clear that compo tubes must not be used, and Rule 40 is practically the same as in the old rules, in laying down the provisions for conductors passing through walls, only it is stated that when the end of the tube is outside the building, it should be bell-mouthed and turned downwards. We believe such ends have been on the market for a long time, and if they have not been generally used, this is simply due to carelessness.

Conductors—Wood Casing for.—Rule 41 defines what must not be done with wood casing. It must not be buried in plaster exposed to moisture, used in damp places, or run below water pipes unless efficiently protected from drip. Another source of damage to wood casing is omitted, namely, the trickling of water through wooden floors which have been washed. We hope the time will soon come when wood casing is barred altogether except where in sight.

Conductors—Precautions at Points of Connection.—We notice that Rule 43 recommends that the covering of the dielectric should be cut back and *waterproofed*, an admission that Rule 29 (in which it is specified that such covering must be prepared *so as to resist moisture*) is not carried out. This was pointed out by us in discussing this rule. The strands of conductors insulated as class (*b*) must be soldered in damp places; this precaution might well be extended to cover all conductors and situations. Rule 44 provides that all conductors larger than 7/18 must be soldered to lugs for connection, and they must be mechanically secured in addition, where there is any strain on the lugs. This is a useful precaution, as lugs often have a way of working loose under strain from the wires.

Switches.—Rule 45 embodies most of the equivalent rule in the old series, with the following exceptions and additions: the base must be "moisture proof" as well as incombustible, but again we must insist on the vagueness of this term; the cover "must be clear of all internal mechanism," but surely the word "live" has been omitted, otherwise no cover with a handle through it would be exempt; it is not now suggested that the cover be lined with non-conducting material; it is recommended that "when the pressure exceeds 250 volts, covers must be of metal and must be earthed"—a very wise precaution which might be extended to 100 volts in damp places: switches must not contain a fuse—a rule which we think has been adopted by supply authorities ever since the introduction of 250-volt supply pressures.

Fuses.—Rule 46 defines the duties and requirements of a fuse more fully than before. Some of the important points to notice are the following:—"That it shall effectually interrupt the circuit when . . . . the current through it exceeds the working rate by 100 per cent. . . . under normal pressure"; the cover, if of rigid metal, must be lined with insulating incombustible material; in fuse boxes or distribution boards "the case . . . . will be a sufficient protection provided the distance from cover to fuse *exceeds two inches*" (a rule which should, we imagine, necessitate alterations in many standard makes); "fuses must not be placed in wall sockets, ceiling roses, lampholders or switch covers" (a practice long since dropped except for Colonial orders); "the fusible metal must be of such a size that no conductor protected by it can possibly exceed the temperature specified in paragraph 23." (We wonder how this last rule agrees with the 100 per cent. excess of current mentioned above.)

Rule 47 prohibits the use of "double-pole" fuses for more than 125 volts, and Rule 48 lays down a general test for size of fuse wires—namely, that they are too large if not warm to the touch on full load, and too small if they hiss when moistened. Rule 49 recommends the use of hard metal for fuses, but that, if soft metal be used, it should be soldered to the contacts. This is somewhat of an innovation, and we should like to know the reasons.

Connectors: Wall—and Floor Plugs, &c.—The only rule which calls for comment under this section is No. 54, which states that all connectors must be controlled by a switch—a practice not sufficiently adopted at present.

Ceiling Roses.—Rule 55 repeats the general requirements for switches and fuses so far as they apply, but permits a ceiling rose to be attached directly to a plastered surface if "it or its base form part of the sheathing" or tubing electrically continuous and connected to earth, as in Rule 12. This exemption should surely also apply to switches and other fittings attached directly to boxes of conduit systems.

Switch and Distribution Boards.—Rule 56 states that these must be insulated where of *hygroscopic material* by bushes from the framework, a rule that is best followed in all cases, because even if the material is not hygroscopic it will condense moisture, and so cause surface leakage to earth. Rules 57—59 need not be quoted, as they only lay down what is now the general practice in switchboard work, but Rule 60 provides for the protection of voltmeters by a fuse on *each* pole.

Fittings for supporting Lamps.—Rule 61 should be studied by those who design fittings, and who are artists but not engineers, for the conductors often have their insulation damaged by rough corners or sharp angles, or tubes too small for the wires. Rules 62—64 are repetitions of the old series, but we notice that it is now not sufficient to insulate adapted gas fittings from the gas pipe; they must be entirely disconnected.

Lampholders.—Rule 65 (*b*) states that these must "be insulated from any continuously earthed conduit or sheath not forming part of the circuit." Surely this must be an

error, as leakage to body is more likely to occur in a lampholder than in any other part of a metallic sheathed circuit, and under these circumstances anyone making a good earth and touching the case might receive a serious shock. Rule 66 provides that switch lampholders should be controlled in groups of 10 or less by a separate fixed wall switch.

Arc Lamps.—The only part of Rule 67 which calls for special comment is that arc lamps must be controlled by linked switches. They are often only controlled by a single-pole switch.

Incandescent Lamps.—Rule 68 (*a*) will hit the lady with a taste for "draping" everything, including lamps. No inflammable material may be used *in contact* with the lamps, and celluloid must not be used for shades.

Rule 69 provides for Nernst lamps, which are amenable to the last quoted rule, and also to those for arc lamps.

Dynamos and Motors.—Rule 70 defines more than one-third of a horse-power as the rating for the conditions named. Enclosed types are not amenable to the 1897 rule regarding proximity of woodwork. The use of machines where inflammable materials are made or stored, &c., is carefully provided for by a clear specification for an enclosed type with special provisions for ventilation if necessary.

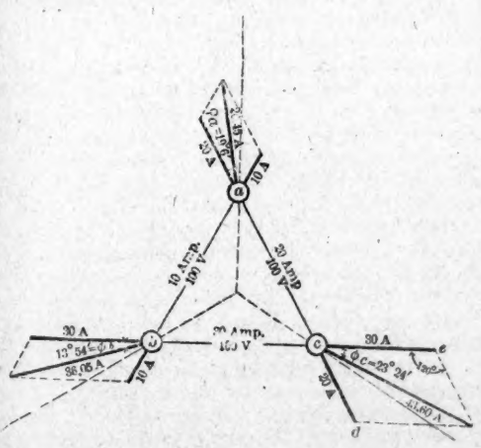
Motors must have an automatic magnetic release on the regulating switch in case the current be interrupted.

(*To be concluded.*)

THREE-PHASE MEASUREMENTS.

In a recent issue of our contemporary, the *Electrical World and Engineer*, Mr. A. S. McAllister remarks that the term "power factor," as applied to alternating current phenomena, is variously defined as "the ratio of electric power in watts to volt-amperes," as the "ratio of true to apparent power," as the "cosine of the time angle between the current and pressure," &c. In single-phase and in independent two-phase circuits, or in any symmetrical and balanced circuit these terms are synonymous, but in interconnected polyphase circuits carrying unbalanced loads the power factor will have practically as many different values as there are terms by which it can be determined.

Take, as an example, the case of a three-phase circuit operating on unbalanced loads, and to simultaneously simplify and exaggerate the case, suppose a non-inductive delta connected load in which the E.M.F. between leads is 100 volts and the currents 10, 20 and 30 amperes respectively per phase. The true power is obviously 6,000 watts, and the power factor is unity.



Referring to the accompanying figure, which represents the value and position of the current per phase, the value of the current registered upon an ammeter at c and its relative phase position may be ascertained by making use of the geometrical figure *c d f e*. From the construction it is seen that the current at *c* is represented in value and phase by the line *c f*. In the triangle *c e f* the side *c f* is equal to

$$\begin{aligned}&(c\,e^2 + 2\,c\,e \,.\, e\,f \cos 120° + e\,f^2)^{\frac{1}{2}}\\ &= (30^2 + 30{\cdot}20 + 20^2)^{\frac{1}{2}}\\ &= 43{\cdot}60\end{aligned}$$

and $$\sin \phi_c = \sin 120° \frac{e\,f}{c\,f} = 0{\cdot}3971,$$

therefore, $$\phi_c = 23° 24'.$$

Similarly the current at *a* is

$$(10^2 + 10{\cdot}20 + 20^2)^{\frac{1}{2}} = 26{\cdot}45,$$

and $$\sin \phi_a = \sin 120° \frac{10}{26{\cdot}45} = 0{\cdot}3272,$$

therefore, $$\phi_a = 19° 6'.$$

Also the current at *b* is,

$$(10^2 + 10{\cdot}30 + 30^2)^{\frac{1}{2}} = 36{\cdot}05,$$

and $$\sin \phi_b = \sin 120° \frac{10}{36{\cdot}05} = 0{\cdot}2402,$$

therefore, $$\phi_b = 13° 54'$$

Now, let W represent power, and place suffixes, so that the first letter of the suffix represents that lead in which the current coil of the wattmeter is placed, and the two suffixes indicate the points to which the voltage coil is connected, then—

$$\begin{aligned}W_{ac} &= 26{\cdot}45 \times 100 \times \cos 19° \;\; 6' = 2{,}500.\\ W_{ab} &= 26{\cdot}45 \times 100 \times \cos 40° 54' = 2{,}000.\\ W_{bc} &= 36{\cdot}05 \times 100 \times \cos 13° 54' = 3{,}500.\\ W_{ba} &= 36{\cdot}05 \times 100 \times \cos 46° 06' = 2{,}500.\\ W_{cb} &= 43{\cdot}60 \times 100 \times \cos 23° 24' = 4{,}000.\\ W_{ca} &= 43{\cdot}60 \times 100 \times \cos 36° 36' = 3{,}500.\end{aligned}$$

It is at once seen that the true value of watts is recorded in each case by the sum of the readings of any two wattmeters with their current coils in separate leads, and their free pressure terminals connected to the third lead, thus:—

$$W_{ac} + W_{bc} = W_{ab} + W_{cb} = W_{ba} + W_{ca} = 6{,}000,$$

but that the true watts may not be indicated by one wattmeter which has its pressure coil free terminal transferred from first one and then the other remaining lead.

It may similarly be shown that $n-1$ wattmeters may be used to determine the true power in any *n*-phase system, however unsymmetrical may be the phase relations, provided the free terminals of the pressure coil of each meter be connected to that lead in which no current coil is placed.

PREPAYMENT METERS.

[COMMUNICATED.]

While the progress made within the last decade in electric lighting in all civilised countries may be pronounced to be extraordinary, with particular reference to large towns, the average price per unit sold has been reduced in several instances to such an extent, that provisions are being made for the adoption of electric lighting in certain districts, so that it may satisfy the poor man's wants without squeezing his purse; but the much-discussed systems of tariff charges must here necessarily play an important part if low charges can be maintained and show a margin of profit; and further, the collection of accounts needs the closest consideration.

The advance of civilisation, and the needs of dwelling space, have convinced the builder and property investor that spacious mansions and residences do not command the same attention from "house hunters" as in former years, and the average being chooses the best planned tenement, with due respect to price and locality; for this reason, the craze for flats, and property of that description, seems to be ever on the increase, from the richest to the poorest.

One of the advantages claimed by tenants of such habitations is that one can countenance a long absence with a more tolerable feeling of security for one's household effects than is possible with a house.

Very small flats are now common, particularly in London and suburbs, which are eagerly sought by those whose occupation claims their presence elsewhere in the daytime; the number of lamps installed varies from three to five, and the account can only be collected at certain hours, which may vary so widely one with another, that the expense of collec-

tion seriously diminishes the profits. It is also found that script or cash payments for small accounts are "dodged" with persistency, and the whole subject calls for something more satisfactory as regards the measurement of current consumed than the ordinary watt-hour or ampere-hour meter.

The prepayment meter obviates most of these shortcomings, and there should be a fortune in store for the lucky inventor of such an instrument as will satisfy the conditions of working reliably on all loads, and will obviate any chance of fraud either on the part of the consumer or the collector. Unfortunately such an instrument, the first cost of which must of necessity be low, has yet to be brought to light in a field which eagerly awaits its advent.

There are various types now on the market which are being freely experimented with, but it cannot be said that perfection in any one of them has yet been reached.

The subject is a fascinating one, but fraught with many difficulties. The chief points to be studied in the inception of such an instrument are as follows:—

1. Cheapness in first cost, since no meter rents are chargeable.
2. Reliability of working under all loads.
3. Absence of friction and complicated mechanism.
4. Eradication of any chance of fraud, either by consumer or collector.
5. Suitable "make-and-break" contacts.
6. Absence of clockwork.
7. Certainty of action of "coin-feed" mechanism.

Under present conditions of the use of electric light, it is probable that more "shilling-fed" meters are in demand than those operated by pennies; with the perfection of the former, the latter will follow in due course, with the brightest prospects for a successful career.

Of the several types of both motor and electrolytic prepayment meters introduced, it may be as well to point out the various principles on which they are designed to work, and the difficulties attending their regular operation.

The choice of coin, resting between pennies and shillings, is alone determined by the class of property to be served, and shillings are more portable on one's person than a host of coppers; it by no means follows that the same design of operating mechanism will answer for any coin chosen, the size, weight and thickness being important factors, which vary considerably according to the age of the coin.

In motor meters the prepayment attachment is geared primarily to the armature spindle actuating the contacts, for which mercury cups are perhaps the least objectionable; the friction of the extra gear, the sparking at the "make-and-break" of contacts, and, in general, the delicate mechanism of an instrument which often receives rough usage, present many difficulties.

The price of these instruments, especially for 1 to 2 amperes capacity, rules high when the revenue is not sufficient to cover the initial cost under a period of, say, two years; to this must be added the annual cost of excitation, if watt-hour meters are used, and the absence of rental charges.

In electrolytic types the weight of the coins operates the immersion of the anode in a bath, or else the gradual evaporation of the electrolyte is used as a means of measuring the consumption.

In these types the fulcrum needs fine adjustment, and care must be bestowed on the filling, and general dry state, of the meter before the latter is sealed up on the consumer's premises; the cost of such meters is greatly in favour of their use if due allowances are made for extra attention and maintenance generally.

In all prepayment meters, the chief difficulty is the detection of fraud either on behalf of the consumer or the collector.

In the case of the former, one remembers the verdict being given in favour of a defendant, in that he fulfilled his obligations towards the gas vendors by putting his coin through the slot of the meter with a string attached, and satisfied his curiosity without charge, because the regulations did not discourage him from withdrawing the coin again.

As regards collection, the money boxes should be under separate cover from the dials, for it is generally possible to rob the till whether the equivalent amount of electricity has been consumed or not. Indications for the tally of coins used, and energy consumed, would meet the case more perfectly.

When a prepayment meter, designed to fulfil all the above mentioned requirements, is brought into the market, the demand will be a great one, for its popularity, even at the present time, gives that assurance.

Thrifty housewives can keep a better check on their expenditure, while the tedious collection of petty accounts, which formerly were possibly doubtful, is to a great extent obviated.

THE LONDON UNITED TRAMWAYS.

It has frequently been remarked that London, the largest centre of population in the world, with necessarily a large proportion of suburban residents, is worse off in the matter of local travelling facilities than any other large European city, and, we might add, infinitely worse off than many in America.

Nevertheless, there are signs that suburban tramways will, in the near future, play an important part in connection with London traffic, and, to a great extent, revolutionise the present conditions. In the west of London, people have for some two years enjoyed the travelling facilities provided by the London United Electric Tramways Co., and south of the Thames, the electric conduit system of the London County Council approaches completion, while North London has its scheme, which will shortly be carried out.

To the London United Tramways Co. belongs the credit of giving London its first electric tramway, which, in point of excellence of permanent way and electrical equipment, has few equals in Great Britain. For some time the company's operations in the vicinity of the Thames have extended as far as Twickenham, and on Thursday last a further extension of some 7 miles of route, with car-sheds and sub-station, was formally opened by Mr. Yerkes.

The route from Hammersmith and Shepherd's Bush to Kew Bridge is very well known, and onwards through the narrow streets of Brentford, with its gasworks, past the historic entrance to Zion House and the junction for Hounslow through regions of orchards which just now are additionally attractive in their bloom, and into Twickenham, should be familiar to many. From this point the new extension commences; the route crosses the river Crane and the S.W. Railway, then the junction for Staines and Richmond. Here the company was under the necessity of building a new thoroughfare, it being impracticable to use the narrow and tortuous old one. Following Heath Road, which the company has widened, the line dips under the S.W. Railway bridge, the road having been lowered some feet to get the requisite head room, and incidentally necessitating the lowering of some seven 36-in. water mains which follow the route, a work which, we are told, cost the company some £24,000.

The line skirts Twickenham Green, following the Hampton Road, which has been widened, and reaches the junction of the loop line at Fulwell. The greater portion of the route up to here is double-track; the loop which encircles Bushey Park is single-track with turnouts. The route passes through Fulwell and Broad Street, Teddington, up a stiff incline and up over the S.W. Railway (the bridge and approaches having been rebuilt wider than the old one by the Tramway Company), winding between the churches of St. Albans and St. Mary's (near where the company had acquired and removed the old church house and considerably widened the road), and passes along the Kingston Road through Hampton Wick, under the S.W. Railway bridge, and along the High Street, in which the company acquired and pulled down a great amount of old property for road widening.

The route leaves Kingston Bridge on the left, this point being the junction with the company's authorised extension over the river through Kingston to Wimbledon, &c., then follows the Hampton Court Road, this portion of the track—*i.e.*, from the Dewdrop Inn to Hampton Court Palace—being paved with granite; elsewhere the company has used wood-block paving.

In this road the somewhat novel spectacle of stately old trees and modern tramway poles, elbowing each other at the side of the road, is seen.

The route passes between Hampton Court Palace (on the left), and the entrance to Bushey Park (on the right), following the boundary of Hampton Court Green (junctions being provided near the bridge, for the authorised extension to Thames Ditton) and the river bank for some distance. Molesley Lock, the Boat House, Tagg's Island and Hurst Park lie to the left of this section of the route; and Garrick's Villa, where the opening luncheon was held, to the right. From here the route passes through the village of Hampton, a considerable length of road widening having been done on this section, and finally completes the circuit, rejoining the Twickenham line at a point just beyond the Fulwell depôt.

From an engineering point of view, the company has undertaken and successfully carried through a great deal of arduous and costly, if not difficult, work, and incidentally has provided some excellent main roads, which but for their enterprise, would probably have never been made.

We understand that all the road widenings up to the present have worked out to some £1,400 per mile of route.

The Fulwell depôt consists of a car shed of three bays, each accommodating five lines, and capable of holding some 200 cars; a fourth bay at the side is used for a repairing shop.

The shed has an entrance at both ends, it being situated in the angle formed by the circular route, and a short distance from the junction, there is an arrangement which provides for rapidly taking the cars out, and gives an alternate route if from any cause one entrance is obstructed.

The sub-station, situated near the entrance gates on one side, is divided into two parts, one containing three 500-KW. B.T.H. rotary converters and a small motor-generator, provision being made for an additional converter and motor-generator. The switchboard, at the side of, but some distance from, the division wall, is similar in appearance to that at the Chiswick power station.

The other part of the building, situated behind the switchboard, contains 200-KW. B.T.H. transformers, reducing the voltage of the three-phase transmitted current from 5,000 volts to 420, the pressure at which it is delivered to the converters. The internal arrangements and appearance of the sub-station are in keeping with the rest of the company's work.

The track and overhead equipment are similar in construction to the first portion of the route, being side-pole and span-wire overhead. Wherever possible double track has been provided, and in several places—notably at Teddington and Hampton—interlacing tracks are laid. Clusters of five incandescent lamps are provided at intervals on the side poles.

In the course of the opening luncheon, Mr. C. T. Yerkes, the chairman, formally declared the line open, and said that the London United Tramways at present occupied 30 miles of streets, including the present extension of 7 miles. They had in contemplation extensions amounting to 20 miles, and extensions of 50 miles had been already granted, making altogether 100 miles of route, which they expected to have in operation in the course of about three years. They had 300 cars on the system, with a capacity for 500,000 passengers a day. They expected to join the London United with the Metropolitan-District Railroad, thus forming a continuous route from the City, and they also contemplated connecting with the Great Northern, Piccadilly and Brompton Railway. At present they had not exploited much to the South, but they had to the East, West and North, and in a very few years they would be able to take people from that vicinity, and also from Hounslow or Harrow to the Channel. When the District was electrified they intended to adopt the system of universal fares which was by far the best.

Mr. Speyer said that, incredible though it might seem, the richest city in the world did not seem willing to provide funds for what was really a public necessity—quicker transit for moving the population expeditiously from one place to another. It seemed that London had to appeal to foreigners for help. The company meant to do the work to which it had set its hand, quickly and well.

Mr. Robinson, in responding, said the London United Tramways had a past upon which its founders looked back with pride, a prosperous present, and a future full of promise. It had few rivals and no superiors, not even in America. It was just two years since the company was enabled to open the first electric system of tramways in London.

THE JOINT COMMITTEE ON MUNICIPAL TRADING.

After an exhaustive discussion, in which the Prime Minister took a distinguished part, the House of Commons has very wisely adopted Mr. Gerald Balfour's motion, and has consented to refer the whole subject of municipal trading to the scrutiny of a Joint Committee. On behalf of those who are interested in an industry which has suffered severely at the hands of the municipal trader, we rejoice that his methods may now be subjected to full and exhaustive inquiry. It is true that Mr. John Burns, who appears in this matter to be the leader of the opposition, has said that public opinion has been influenced in this matter by company promoters and others whose antipathy to municipal trading "is equal to their own incapacity to manage their own affairs," and that apart from their request there is no tittle or shadow of a public demand for this inquiry." We take leave to differ entirely from this expression of opinion. One has only to glance at the columns of nearly every technical paper to see that numbers of people, representing interests which are widely divergent, have long been clamouring for the appointment of a Committee; and that so far from the opposition being in the hands of a few company promoters, ratepayers throughout the country have begun to view with alarm the rapid increase of municipal debt.

One might have thought that, inasmuch as Mr. Burns is a firm believer in the present system, and an ardent advocate of its extension, he would have welcomed the proposed inquiry. But this is not so. He and his supporters, content to quote columns of figures in support of their view, put forward a violent opposition to the appointment of a body who are to be entrusted with the duty of making an impartial inquiry. Does the man who burkes the criticism of his actions really believe in their absolute integrity? Speaking after Mr. Burns in the House of Commons, Mr. Cohen said: "I am astonished that the inquiry should be objected to by members like Mr. Burns, who profess to have such a great confidence in the merits of their own case. Personally, I have never objected to municipal trading. What is called municipal trading is very often useful and necessary; but before a municipality undertakes any service, it should be shown that it is necessary for the general well-being, and that it could not be as successfully carried out by private enterprise. If it can be as well and as cheaply performed by private enterprise, there was every argument in favour of its being so undertaken."

There are two or three matters in relation to this subject to which we should like to draw attention in the hope that they may be dealt with by the Committee.

In the first place, the delimitation of local boundaries has in the past frequently curtailed the development of electric tramways on a large scale. Unable or unwilling to agree among themselves, local bodies have refused to allow private companies possessed of ample resources to undertake work of immense benefit to the inhabitants at large.

The South Staffordshire Tramways Bill, which came before Parliament in 1898, affords striking evidence of the way in which this lack of power to combine prevents a number of local authorities from working the tramways over a large district. There the promoters (an electrical company) sought to amalgamate all the tramways which lay in and between the numerous boroughs in South Staffordshire, and to work them electrically. Dudley, Walsall, West Bromwich, and a number of other towns were to be included. The South Staffordshire Tramways Co. have for some years worked a tramway in a portion of the district in question. In order to prevent the immediate purchase of their undertaking by the various local authorities, the promoters sought to obtain the insertion in their Bill of a clause which would prevent their tramway being purchased until a period of 35 years should elapse from the date of the Bill. It was further suggested that at the end of that time the local authorities might be allowed to purchase the undertaking as a going concern. This clause was fiercely opposed by the local authorities, who never attempted to come to any agreement for working conjointly. Indeed, for them to come to any such agreement would have been

exceedingly difficult, inasmuch as the periods within which they were entitled to take over the tramways in their different districts came to an end at different times. Nevertheless the opposition of the local authorities was so strong as to persuade the House of Commons to throw out the Bill.

Again, it is not always certain that the policy adopted by the local Council will commend itself either to present or to future generations of ratepayers.

In this connection we may briefly refer to the case of the Finchley Electric Lighting Co. *v.* The Finchley Urban District Council, upon which we commented at some length a few weeks ago. There the company, who were acting under no provisional order or Act of Parliament, suspended cables across certain highways in the district of the defendant Council, with a view to supplying electricity to consumers. The Council ordered the wires to be cut down, on the ground that their suspension over the highway amounted to a trespass. Upon this the company promptly applied for an injunction, which was made perpetual in the Court of Appeal only a few weeks since. On the face of it there does not appear to be anything extraordinary about this case; but its true meaning is brought into relief when we mention that the defendant Council were the proprietors of a provisional order which they had never put into force. So utterly were they out of touch with the real needs of the district that instead of taking action to supply, they took active steps to prevent it. What the present local politics of Finchley may now be we cannot say; this case commenced in 1901. But we take the liberty of citing it as an instance of obstruction.

The facts relating to the purchase of the undertaking of the Metropolitan Electricity Supply Co. in St. Marylebone by the Borough Council of that district should also be brought to the notice of the Committee. After certain disputes had taken place between the company and the Council, the latter body applied for and obtained Parliamentary powers to take over the plant, &c., belonging to the company within the district. The price was to be fixed, failing agreement, by arbitration. A court of arbitrators was duly constituted, and after a lengthy inquiry they assessed the purchase price at £1,212,000, which was something over a million less than the original price claimed by the company, So far from acknowledging the justice of this assessment, the Borough Council at their last meeting referred the matter back to their Lighting Committee, in order that counsel could be instructed to advise as to what steps should be taken to get behind the award. Granted that the price is overwhelming, even admitting that the present Councillors are justified in hesitating before they involve their ratepayers of St. Marylebone in a debt of this magnitude, we fail to see how the predecessors in office of the present Council ever came to entertain such a project without carefully estimating the probable cost.

There is another aspect of municipal trading, to which we hope the attention of the Committee may be directed. We refer to the important bearing which municipal trading must always have upon the local elections. In many towns which have advanced far along the road towards that Utopia where every trade and industry is in the hands of the local Bumbles, the selection of the Councillors depends upon the views which they may happen to hold with regard to a system under which employment is provided out of the rates. It is obvious that to make the question whether a man shall vote for a particular candidate dependent upon the direct monetary benefit which he may derive therefrom, comes perilously near corruption. This influence has already been experienced in the House of Commons; and it is possible that the Committee may have to inquire into the question of how far dependence upon employment which is provided out of the rates, should prohibit an employé of the local authority from recording a vote.

We sincerely trust that all matters of this kind will be submitted in their due perspective to the members of the Joint Committee, who will be able in their report to state whether, in their opinion, municipal enterprise, financed as it is, by stupendous local loans, has proved so successful that it merits further extension. The object of the Committee being, apparently, to frame clauses which can be made common form in all Bills which authorise municipal trading, it will be possible for them to find a remedy for some of the evils to which we have drawn attention.

CORRESPONDENCE.

New Exhaust Silencer.

I notice you have an article on a new exhaust silencer. It may interest your readers to know that five years ago I used a very similar device in connection with a 25-H.P. gas engine, the only difference being that my arrangement was somewhat simpler and less costly.

The arrangement I adopted was:—I used two of the ordinary pattern silencers or choke boxes, one of which was placed in the trench, and the other one was laid into the bottom of the exhaust pit. This exhaust pit was 6 ft. long × 4 ft. wide × 6 ft. deep, and the water level was just over the top of the exhaust box. The top of the pit, which, by-the-bye, was in the engine house and just at the back of the engine, was covered by an iron plate.

The result was perfectly astonishing. It was highly necessary in this case that every bit of noise should be deadened, as there were living rooms immediately over the engine house, and it was possible, while the engine was running at full load, to sit in the rooms above without the slightest sound being heard. I may say that the exhaust was taken from the pit directly into one of the ordinary chimney shafts of the building.

Edward L. Joseph.

Canonbury, *April 3rd*, 1903.

Commercial Management of Tramway Undertakings.

The points dealt with in the criticism of Mr. Sheffield's article on the above in February's *Fielden's Magazine* by Mr. Wordingham are very important, not only to the electrical engineer, but also to the public. Hints like these, coming from such an authoritative source, should readily commend themselves to the consideration and attention of our tramway engineers.

In these days of fast travelling, the subject of automatic signalling very forcibly presents itself, and must be grappled with, and the sooner that is done the better, both for the public and the tramway managements. Where the system has been adopted it has been with "signal" success, and the greater security would well repay the initial cost. The suggestion of "cutting off" the current from a given portion of line, while very good in itself, seems to me quite unnecessary where a system of signalling is in operation, as, in my opinion, where we have motormen who will not observe danger signals, the sooner they are replaced the better.

I am quite in concurrence with Mr. Wordingham regarding wattmeters being unnecessary as part of a car equipment; readings are very easily got without saddling the undertaking with extra wattmeters, especially in large undertakings, where, as, for example, Manchester, when completed with 800 cars, 1,600 wattmeters is a big item.

In regard to life guards, I am at one with Mr. Sheffield as to their being very essential. Just a few evenings ago I was proceeding homeward, when a very fine example of the efficiency of the life-guard came before me. A lad about 15 years of age left a house gate to board a car approaching on the "off track," which was just left of a stopping post 25 yards further back. The lad was crossing the line when he slipped and fell, and the car was upon him: the guard was of the drop-gate type, and worked beautifully, and the lad was picked up. When the car was brought to a standstill he came out quite unhurt but for a couple of skin scratches and a torn jacket; but for the fine work of the life-guard he would certainly have been cut to pieces. From my point of view, the most important item in the letter is one in which every car traveller is interested; I refer to the subject of overcrowding. While we had horse cars, the police and the N.S.P.C.A. took an interest in the motive power, and insisted upon proper loads with increased comfort, but now that interest is gone, and we are left, as Mr. Sheffield says, to the mercy of "avaricious committeemen." In a large city in Northumberland, where the Corporation control the tramways, the cars on some of the routes are single-deck bogies, and inside there is painted the

legend, "Car No. —, constructed to carry 55 passengers; seats for 37 passengers," thus showing an excess of 18 passengers who have to stand up in the centre of the car and on the platform end. I have myself seen the conductor of a car standing on the bottom step of the platform quite out of reach of the communication bell, and he found it easier to call "Right" to the motorman from the roadway as a signal to start than to force his way to the "push"; this is in a city where a passenger who spits on the car floor is threatened with legal proceedings and a fine of 40s. and costs. I have certainly no sympathy with such a vulgar habit, but just point this out to show the gross inconsistency of the management; unfortunately, this practice is not confined to the city to which I refer, but is the rule rather than the exception.

Just a word about motormen. From my experience of most new undertakings these men when engaged, get a couple of weeks' so-called training, and are sent out on the road to take care of a car and 50 (more or less) passengers, and if the staff happens to be short, then conductors are pressed into service. The guard is made engine driver. This, I should say, is another matter for the Board of Trade. Surely, if experienced men are required anywhere it is at the controller—men adequately paid, and with proper hours per day. To take a car through a city's traffic, a clear head is wanted as well as a steady hand, and the driver must be conversant with the power, and every part, of his machine.

J. McF.

On Coherence.

Seeing what great interest is manifested at the present time in the subject of wireless telegraphy, it has often struck me as peculiar that I have never seen the subject of coherence, *i.e.*, the actual *cause* of coherence, clearly explained; the fact is, of course, well known that when an electric, or so-called Hertzian wave, strikes a coherer, the filings, or other material which may be used, will cohere, and the normally high resistance of these filings is thereby greatly lowered; we also know that a sharp tap or other mechanical agitation of the filings will now cause these filings to decohere, with the result that the resistance of the filings will again increase to its normal amount; but can we yet explain definitely what is the actual *cause* of the coherence of the filings, why do they, as it is called, cohere on the advent of a Hertzian wave, what force manifests itself on the advent of this Hertzian wave that causes these filings to cohere? These are some of the questions which the writer has often asked himself, but which he has never yet seen clearly explained; these questions may long ago have been answered, the very conclusions even which I have come to on this subject may at the present time be well known; however, be that as it may, this letter is written in all humility, and some of your readers will probably add also in ignorance. But if it is of the slightest interest or use to any of your readers, the writer's object will be attained. The following is my explanation of the *cause* of coherence, but, before stating my opinion, let me enumerate two well-known simple facts which have led me to come to this opinion.

1. We know that when a rod or bar of iron is traversed by magnetic lines of force, that this rod will increase slightly in size in a direction parallel to the lines of force, and when withdrawn from the magnetic field, that it will again assume its normal size. This applies, of course, only to soft iron, which retains its magnetism only while in the magnetic field. As a matter of fact, according to Joule, a rod of iron, when under the influence of magnetic lines of force, will increase about $\frac{1}{500000}$ part of its length.

2. We know that a simple coherer, consisting of two electrodes in contact with metal filings, will cohere on being brought into a magnetic field. A simple experiment illustrating the above can easily be performed by winding a few turns of wire around the glass tube of a simple metal filings coherer, it will be found that the filings will cohere when a current is sent through the coil. Now, in this case, coherence is due simply and solely to the magnetic lines set up by the coil; we can explain the action of the magnetic lines upon the filings more minutely as follows: When a current is sent through the coil of wire, a magnetic field is set up by the coil, whose lines are in a direction parallel to the glass tube of the coherer, the metal filings, which have up to the present been, as children would say, all "higgledy-piggledy," and in loose or imperfect contact, are now suddenly straightened out by the magnetic lines and placed all in a direction parallel to the tube—*i.e.*, parallel to the lines of force. Now, as we know from "fact 1," each of these minute metal particles increases while under the influence of the magnetic lines slightly—very slightly—in length, but quite enough, I think, to cause the little particles to be pressed, as it were, against each other, owing to the fact that each particle now occupies more room than it did before it was influenced by the magnetic lines, with the result that the loose or imperfect contact which existed between the particles before the advent of the magnetic lines is now converted into a good, or comparatively good, contact, because of the fact of the particles being now pressed against each other, this having the effect naturally of lowering the total resistance between the terminals of the coherer. When the current is cut off from the coil, the magnetic field, of course, ceases. Now, in what way does this cessation of magnetic lines affect the filings? According to "fact 1," the filings would now all diminish in length slightly—*i.e.*, they would return again to their original sizes—with the result that the good contact which existed between the particles of metal during the duration of the magnetic field would be broken down, and the particles would once again be in loose and imperfect contact with each other, the effect of which would be again to increase the resistance between the coherer terminals. If the above theory is correct, and if it also explains the action which a Hertzian wave has upon a coherer, is it not evident that the filings of any coherer do cohere and decohere under the influence of magnetic lines and Hertzian waves without any mechanical aid. It is easy to realise that to cause the filings to thoroughly separate or decohere would require the aid of a slight tap or other mechanical aid. One of the first to notice this effect—viz., that a coherer will decohere without any mechanical aid—was, I believe, M. A. Popoff, and it is, of course, on this principle that his self-restoring steel needle and carbon coherer operates. Among other self-restoring coherers may be mentioned the "Castelli" coherer, and also the "Royal Italian Navy" coherer, as it is called.

Now that we have studied the action of a coherer under the influence of magnetic lines, let us see in what way does this action differ when the coherer is under the influence of Hertzian waves. Experiment has shown that, as far as results are concerned, the results in both cases are identically the same. What I mean by this is that as far as we can see, the filings of a coherer behave under the influence of Hertzian waves in an exactly similar manner as they behave under the influence of magnetic lines of force. From the above theory it seems to me probable that in wireless telegraphy the coherence of the filings in the coherer is due simply to intense magnetic lines or waves, not electric or electro-magnetic waves, which are emitted from the oscillator or transmitter at the sending station; these waves on striking the coherer magnetise the filings contained therein, so causing them to cohere, and allowing an intelligible message to be recorded. I also maintain from the above theory that the filings of *any* coherer do *decohere*, to a certain extent, *without* any mechanical aid.

In the Electrical Review of May 23rd, 1902, an interesting article appeared under the title of "Electric Waves and their Effects on the Human Brain." This article described a series of experiments conducted by A. F. Collins, in which the following three propositions were proved:—

1. That cohesion of the brain cells in mammals takes place after death under the action of electric waves.

2. That cohesion of the brain cells of mammals in life takes place under the action of electric waves.

3. That cohesion of the brain cells in man after death takes place under the action of electric waves.

Now would it not be of interest to determine whether cohesion of the brain cells in either of the above three cases would take place under the action simply of magnetic lines of force or magnetic waves, and so determine in another manner the similarity of the cohering influence of magnetic lines of force and Hertzian waves.

W. P. B.

The Ljungstrom High Speed Engine.

Referring to a short article which appeared in your Journal on January 23rd, which has now been brought to my notice, there is a question asked as to where the Ljungstrom engine has hidden itself.

With your permission, I would inform your contributor and readers that this engine has not been heard much of for the past year or so on account of difficult commercial negotiations only, and in no way through any mechanical defects in the engine. In the meantime, whilst the commercial matters referred to have been in negotiation, the original Ljungstrom Engine Syndicate has carried out the work for which it was constituted, viz., the building of a few engines of representative sizes, and putting them to work in daily operation to prove their durability, the chief point on which information was lacking, for, at a very early period of its existence, the engine was proved by independent expert tests to be most economical in steam consumption and efficient in work. Engines of 16, 25, and 100 B.H.P. have been built and put to work. The best independent testimony I can give you is as to the working of the 25 H.P. engine which was built specially for Messrs. John Brown & Co., Ltd., Atlas Works, Sheffield, and coupled direct to a "Sirocco" fan for induced draught under the Ellis & Eaves patent, on a boiler in their works. This has now been in use for over nine months, and for six weeks of this time it was kept running night and day, and Messrs. John Brown & Co., Ltd., have, in writing, expressed their complete satisfaction with its working and the simplicity and compactness of its construction.

After this spell of daily work a test was made only last week to learn the steam consumption, and this proved to be 38·3 lbs. of steam per B.H.P. per hour, with saturated steam, a performance which proves the engine to be much more efficient than is usually the case with single-expansion engines of moderate power.

The engine lends itself very readily to compounding or to multiple expansion working, and obviously it will derive at least as much benefit from this as any other.

I enclose a cutting from the *Newcastle Daily Journal* of 10th inst., from which you will see that the commercial matters have been arranged, and a new company, entitled the Ljungstrom Engine, Boiler and Condenser Co., Ltd., has been formed to take up the manufacture of the engine, and a boiler and condenser, also of great merit, invented by Mr. F. Ljungstrom. These latter have also been put to practical test in the immediate past with most satisfactory results.

I think, under these circumstances, your contributor may expect to hear much more of the Ljungstrom engine shortly, and will find that it does not rank among engines that have disappeared.

A. W. Brewtnall,
Secretary to the Ljungstrom Engine, Boiler and Condenser Co., Ltd.
R. Darnell.

April 2nd, 1903.

Municipal Loans.

I have read your "Editorial" of March 27th on "Municipal Loans," and wonder what can be the meaning of the following :—

"Thus in the matter of mains, which constitute so large a part of the outlay, 2½ per cent. is considered a proper provision for depreciation, or, say, a life of 40 years, whereas the Local Government Board fix the repayment at 30 years."

I congratulate you on coming to the same way of thinking, as I have previously expressed on several occasions in letters to your valuable journal, viz. :—that the repayment of a loan is a provision for depreciation, otherwise, what does the above mean? It is interesting to me to also note that the life of the plant takes such an important part in the number of years the loan is granted for. I have often wondered why you refused to take this view before, as to me, it seems only the natural one.

There is a small error in your figures. For instance, you kindly refer to me as stating that depreciation on machinery at 4 per cent. constitutes a life of 25 years. I would point out to you, that all municipal loans are repaid with compound interest, and, therefore, 3 per cent. should repay a sum of money in 25 years, and not 4 per cent.

Again, you point out that for accumulators to last 10 years, 10 per cent. per annum must be set aside—which is incorrect. 8 per cent. on the outlay would repay the loan in 10 years.

I am not aware that the London County Council adopt any principle different from that of the Local Government Board, except that they unwisely grant the loan for 42 years, which is too long a period, and the Local Government Board are much wiser in keeping to the 25 years. It is, however, the practice of the Local Government Board never to grant a new loan for renewal of plant purchased by former borrowings. I have attended some ten or dozen inquiries, and must emphatically say that the inspector when holding the inquiry is most particular as to whether any of the money proposed to be borrowed is to cover any renewal of plant purchased by a previous loan. On many occasions I have had the required loan cut down, simply because a small portion of the brickwork wall had to have a large hole cut in it, and that this brickwork had been paid for by a previous loan, and therefore a deduction was made from the new loan, and the balance had to be charged to the current revenue account. I am not aware of any Corporation paying for renewal of plant out of new loans, until the total loan is paid off; they are certainly not allowed to do so by the Local Government Board, and, of course, if they did, the result would be financial suicide.

I shall be pleased, on my return from Italy, to give you the amounts of each loan, with the sinking fund repaid, and the amount paid out of the current revenue account, for the maintenance of the plant, as these figures are carefully kept by this Department.

I welcome you, dear Mr. Editor, as a "convert" to the fold of those who believe that the redemption fund does form part, if not the whole, of the depreciation necessary to buy new machinery when the old is done for.

H. Boot,
Consulting and Resident Engineer.

Tunbridge Wells Electricity Works,
April 1st, 1903.

[We are almost disposed to say with Dr. Johnson, that if we find arguments, we do not undertake to supply brains for understanding them; but it is really amusing to read Mr. Boot's reasoning in favour of the idea that because the payment of *original cost* is made by sinking fund, or, in other words, by annual instalments spread over a term of years (the loan being earmarked for the purpose, and not legally applicable either for maintenance or renewals), such repayment is a provision for depreciation.

The period of the loan is supposed to be based upon the equated life of the security, the original value being extinguished by the time it is paid for, and any asset remaining being due to maintenance and renewals provided for by other sources than the original loan; hence our remarks upon the difference in the terms enacted respectively by the Local Government Board and the London County Council, and the variations in the percentage calculated for depreciation by different engineers.

If the loans are not paid annually, but the amounts set aside and invested at compound interest, the outlay would, of course, be covered in fewer years, but it is equally clear that if 2½ per cent. of the cost of mains, for instance, were actually repaid every year, the total would only be reached in 40 years.

Mr. Boot does not appear to comprehend the difference between first cost and depreciation, if he really thinks that when he has paid the former he has provided for the latter.

Suppose he paid cash for his plant out of rates collected for the purpose, on the same principle that a private company employs the capital subscribed by shareholders, would he contend that in paying the accounts he has provided for depreciation and antiquation?

We shall welcome the promised statement of the application of the loans raised by the Tunbridge Wells local authority, as our correspondent promises evidence that no new loan is ever applied for renewing plant for which money was originally borrowed.

Evidence of this kind will be very useful for the Parliamen-

tary Committee when they renew their meetings, and if a profit can be shown after charging revenue with all the contingencies arising out of wear and tear, obsolescence and depreciation, we shall be pleased to recognise the sound commercial result which Mr. Boot claims for Tunbridge Wells.

According to the published accounts for the sixth year of working, a surplus is claimed of £440, but as the capital expenditure is stated to be £65,934, and the amount provided for sinking fund £1,586, or, say, 2·40d. per cent., it will be interesting to see how Mr. Boot provides for original cost of plant and the depreciation; he admits that the payment of the original loan requires 3 per cent., and we should add another 3 per cent. to meet depreciation, &c.

The total costs appear to be 2·53d. per unit, and the public lighting realises only 1·75d. per unit, leaving a substantial loss, which must be made up by the private consumers; but we must await enlightenment upon all these points until the promised analysis of the accounts is before us; meanwhile, while wishing Mr. Boot a pleasant visit to Italy, we fear that we cannot accept the position of converts to his system of accountancy, nor his congratulations upon our belief in the fallacy of the sinking fund providing for anything beyond the original cost of plant.—Eds. Elec. Rev.]

Many thanks for your kind reply to my query. I am pleased to note that you are not responsible for the practice of dividing 100 by the percentage annually put aside for depreciation, in order to determine in how many years the capital cost will be accumulated. I take it that you agree that this is not a correct way of computing the time.

As to your query, I gather from published records, for which I am not responsible, that there are several municipal stations of about the size you name generating electricity at a figure approximating that stated by you.

By the way, I did not say your article was "anti-municipal." It was your "municipal" expert I alluded to. It is hopeless to argue with anyone who is merely *anti*-something or other.

F. B.

[Reply to "S."—Hiko compound for electric commutators is made by Mr. A. S. Hickley, 17, Dorset Street, Southampton, Hants.—W. D.]

TRAIN LIGHTING EQUIPMENTS.

By E. KILBURN SCOTT, M.I.E.E., A.M.I.C.E.

At the meeting of the Institute of Electrical Engineers of America, on February 27th, 1903, Messrs. Elmer A. Sperry and Arthur J. Farnsworth read papers on this subject. Mr. Sperry traces the first attempt at train lighting to August, 1882, when the Pennsylvania Railroad Co. electrically equipped a car with Faure accumulators, specially sent over from France for the purpose. The first English railway to take up the subject was the London, Brighton and South Coast in 1883, and they started right away with the system that is probably the fittest, namely, axle-driven generators; the difficulty of leaving the cars in darkness on breaking up a train, being solved by means of batteries under each car.

Seeing that electric lighting was successfully adopted so early, and that there are several good systems to select from, it is not creditable that electric train lighting is still the exception, instead of the rule, and the patience of the public in putting up with the faint glimmer, which is still characteristic of many lines, is remarkable.

After all, the adoption of electric light is not an expensive matter, as it does not involve any alteration of rolling stock, and even if the entire apparatus had to be replaced every few years, it would not materially affect a railway balance-sheet. Why, then, should the good nature of the public be taken advantage of? The electrical trade is hungering for work, and almost giving plant away, and yet we stick in the mud.

Railway officials consider, and consider, and consider. Independently of the bad light, gas and oil are exceedingly dangerous, for in nearly every serious collision the train catches fire. Railway companies have, indeed, richly earned the severe shaking up they are going to get from electric tramway competition.

Briefly, there are three systems of train lighting:—

(*a*) A battery on each car which is charged or recharged at the stations or car sheds as may be required. Nearly every important station or sorting siding has its own electric light plant nowadays, so that there is not any trouble in charging.

(*b*) A steam-driven dynamo on the locomotive or in the guard's van. Such dynamo need not necessarily be driven by a reciprocating engine; turbines ought to suit very well for such work, as they take up little space and do not vibrate.

(*c*) Each car fitted with its own axle-driven dynamo and battery of cells with a variable speed gear or voltage regulating device to keep the pressure constant, whilst the speed of the driving axle is varying from a few miles an hour up to 60 or more.

Incandescent lamps, as made at present, are very sensitive to charges of potential, the candle-power varying as the fifth power of the voltage, and this in itself is a problem which lamp-makers would do well to tackle, for independently of train lighting, there is an opening for lamps less sensitive to variations of pressure.

Systems employing slip frictional driving devices have been fairly successful, but they are open to the objection of power absorption and quickly wearing out. Belts are used on about 90 per cent. of the existing axle-lighting devices in the world, the elastic connection between the axle and dynamo spindle being a particularly valuable feature.

In the system described by Mr. Farnsworth the motor is shunt wound, dust proof and driven by a rubber belt from the axle. The armature shaft carries a worm gear and cam which throws over a switch when the direction of rotation is reversed, so that the polarity of the dynamo remains the same. The fields are laminated and contain a few sheets of hard steel, which retain sufficient residual magnetism to

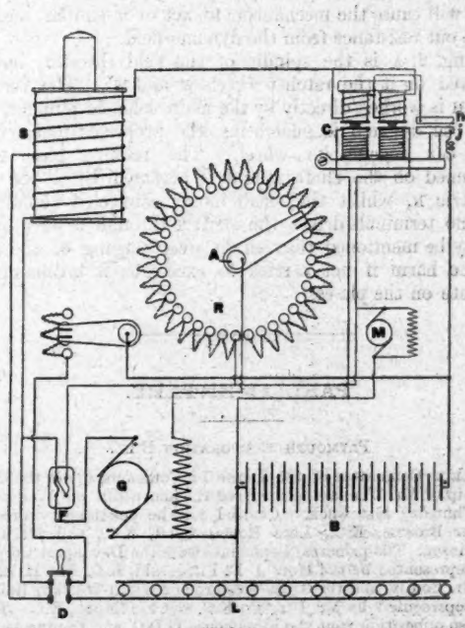


Fig. 1.

enable the dynamo to build up its voltage promptly at low speeds. The principle on which the system works is based on keeping the dynamo output constant by varying the resistance in the field circuit to correspond to the varying train speed.

Fig. 1 (from *Electricity*, U.S.A.) gives the diagram of connections, and it will be noticed that the automatic switch has four bobbins. The two lower ones are wound with fine wire and the two upper ones with heavy wire to car-

the main current. As the train accelerates, and the voltage builds up, current flows through the fine wire coils until it reaches the battery voltage, when the magnetic pole of these coils causes the switch to connect the dynamo and battery in multiple with the lamps. The main dynamo circuit is then complete from the dynamo G, fuse F, solenoid S, two thick wire coils C, cut-out switch *h j*, battery B, and back to the negative terminal of dynamo G. When the lamps are on, the current divides, part going through the resistance E to the lamps. As the speed of the train increases above the critical speed, that is to say, the speed at which the cut-out goes, in the dynamo, the current increases in proportion until it reaches the point where the magnetic pull on the solenoid balances the pull of its opposing spring. Any further increase of train speed will cause the solenoid to be over-balanced and throw into gear a ratchet mechanism, fig. 2, which moves the generator field rheostat arm

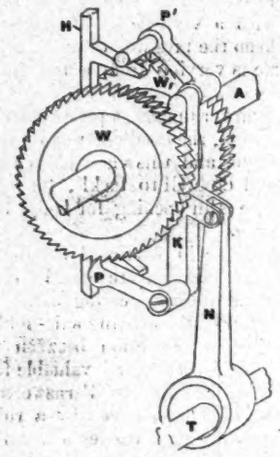


Fig. 2.

until the current is cut down to the proper amount and the solenoid plunger is again in equilibrium. A *decrease* in speed will cause the mechanism to act in a similar manner to cut out resistance from the dynamo field.

In fig. 2, A is the spindle of the field rheostat, having mounted on it the ratchet wheels W and W'. The vertical piece H is worked directly by the main solenoid plunger, and when the dynamo is generating the proper current neither pawl can engage its wheel. The rocking piece K is fulcrumed on the shaft A, and is actuated by a rod and eccentric N, whilst the small motor connected across the dynamo terminals drives the shaft T through a worm gear. It may be mentioned that slight overcharging of the cells does no harm if not carried to excess, as it breaks up the sulphate on the plates.

PARLIAMENTARY.

Plymouth Corporation Bill.

A Select Committee of the House of Commons, under the chairmanship of Mr. Tennant, considered the above Bill on Wednesday and Thursday last week. Counsel for the petitioners were Mr. Balfour Browne, K.C., Lord Robert Cecil, K.C., and Mr. C. C. Hutchinson. The principal opponents were the Devonport Corporation, represented by the Hon. J. D. Fitzgerald, K.C., Mr. H. Lloyd, and Mr. Bodily, and the Great Western and South-Western Railway Cos., represented by Mr. Pember, K.C. and Mr. Moon, K.C. There was also opposition from the Stonehouse U.D.C. and frontagers.

Mr. Balfour Browne, K.C., in opening the case for the Corporation, said it was proposed to construct a number of tramways in the borough. The railway companies objected to these on the ground of competition, and also to the tramway No. 6, which crossed the railway by means of a bridge at North Road. Tramways 11, 12 and 13 carried the system to Crownhill, and these were outside the borough. The Devonport Corporation were also promoting a scheme to Crownhill before the Light Railway Commissioners, but the Commissioners had decided to wait until Parliament had arrived at a decision on the Plymouth Bill before giving their decision. Plymouth was being supported by the local authorities concerned, while Devonport was not. Allegations had been made as to the financial position of Plymouth which were untrue, and he contended that the financial position of Plymouth was sounder than that of Devonport. Last year the Plymouth Corporation carried 6,412,068 passengers on the tramways. The rates of the town were high, but the ratepayers had had value for their money. Of course, they could not make new tramways without laying something on the rates, while they were being constructed, but there was not the least necessity in what they were proposing to increase the rates. It was alleged by Devonport that the tramways and electric light undertaking had been carried on at a loss, but the statements were unfounded. After payment of interest and sinking fund, the net profit on the electric light had been £347. On the other hand, Devonport could not last year pay their interest and sinking fund. When horse traction was used on the tramways at Plymouth they did not pay, and they were taken over by the Corporation from a bankrupt company. During the past two years, during which the tramways were partly electrified, they had paid their interest and sinking fund, and reduced the deficit of £8,700 which existed in the days of horse traction to £5,000. The gross profit on the tramway capital outlay amounted to 6·8 per cent., while Devonport, on the other hand, was doing no better, because its profit was only 6·14 per cent. It was absurd for Devonport to say that the tramways to Crownhill would not pay, because Devonport was trying to get the very same power, out of which a private company hoped to gain a handsome profit. Undoubtedly the two towns were in competition for the same route, and he hoped to be able to prove that it should be put into the hands of his clients. The railway company also alleged that their signalling apparatus would be injuriously affected by the use of electrical power, but such an objection must have been fished up from the archives of the company of 20 years ago, for certain model clauses were always now inserted for the protection of railway companies.

Mr. J. H. Ellis, town clerk of Plymouth, was called in support of the Bill. The Corporation were against municipal trading, and when they bought the tramways they advertised and did their best to lease the working of them, but failed to get anyone to do so. The main object of the tramways was to converge upon the railway stations and to feed them, and they did not compete with the railways. They proposed to work all their tramways from their present generating station, which was equal to working them. They had ample space for extensions, and were seeking money to carry them out. Under the Bill they were seeking power to raise £105,400, of which, roughly, £72,000 was for tramways and £38,000 for electricity. The construction of the Crownhill line would cost about £25,000.

In cross-examination Witness denied that the real object of the Bill was to get the powers to construct the Crownhill lines, so as to keep Devonport out.

It was agreed that the tramway part of the Bill should be completed before the financial part was gone into, and a large number of witnesses were called to prove the convenience the proposed tramways would be.

The town clerk of Devonport was called in opposition to the scheme, and was examined with a view to showing that there was a greater community of interests between Devonport and Crownhill than between Plymouth and Crownhill. The Devonport Corporation leased their tramways, and if their scheme to Crownhill was sanctioned that also would be leased. Devonport were the pioneers of the scheme to run tramways to Crownhill.

Other evidence of a similar kind was given.

Mr. Charles Chadman, the engineer of the Devonport line, said the best route would be that from Crownhill to Devonport, because communication could still be kept with Plymouth *vid* Peverell Park Road. He quite agreed that it would be well if Plymouth had the construction of the line and Devonport had running powers over. That would be a simple and reasonable solution of the problem.

Lord R. Cecil asked if witness did not know that Plymouth was willing to give these running powers.

The Chairman: Do you mean to say that either one of these parties is willing to construct the line and give the other running powers over it, and we have been sitting here arguing all this time?

Mr. Fitzgerald said he did not think Plymouth was in earnest about it.

After an adjournment the Chairman said the Committee had decided to grant the powers mentioned in the Bill subject to conditions, and it was the opinion of the Committee that a definite time, something less than that stated in the Bill, should be given for construction, and that running powers should be given to the Devonport Corporation.

The Committee afterwards proceeded to deal with the financial part of the Bill which was of an important character, as in addition to the sums required for the tramways and electric lighting undertaking it included proposals for the extension of existing loans over a period of 60 years from March 31st of this year, and an application for further borrowing powers in respect of markets, asylum, sewage works, &c.

The Chairman, after an adjournment, stated that the Committee had had an interview with the representative of the Local Government Board, and they had gone thoroughly into the case of Plymouth finance. The Committee could not pass the preamble of the Bill unless they received a recital in it of all the sums of unauthorised capital which had been expended with the allocation of each amount. With regard to Clause 94, that dealt with finance and rating, and was the most important clause so far as borrowing sums of money was concerned. The Committee might be prepared to agree to the £87,785, which was for the construction and equipment of tramways subject to proof, because they were impressed with the case made for the Crownhill tramways. Then there was the figure of £105,400 for the purchase of lands and buildings, the provision of plant and other purposes of the tramway and electric light undertaking. The Committee would be prepared upon proof to listen to so much of that as related to the tramway undertaking. With regard to the electric lighting undertaking, he thought the

Committee should have power if it were proved to be necessary to ask the promoters if their margin of borrowing powers was not sufficient, to go to the Local Government Board and prove the necessity for further borrowing powers. The chairman then proceeded to deal with the financial parts of the Bill which related to matters not electrical.

After some discussion amongst the counsel engaged, it was decided to adjourn the matter until after the Easter recess.

City and North-East Suburban Electric Railway.

This Bill came before Mr. Compton Rickett's Select Committee of the House of Commons last week. Counsel for the promoters were Mr. Balfour Browne, K.C., with Mr. Bush, K.C., and Mr. Page, K.C., and there were several petitions against the Bill, including one by the Corporation of London.

Mr. Balfour Browne, K.C., in opening the Bill, stated that the proposed railway would start from the Monument, and would be a tube railway as far as the Avenue, Tottenham, from whence it would proceed to Chequer's Green by an overground line. At Hackney would start a branch line (tube for part of the way), taking a north-easterly direction, and passing through Leyton, Walthamstow, Chingford to Waltham Abbey, passing Epping Forest on the right-hand side of the line. Counsel stated that that portion of the line from the Monument to Chequer's Green was passed by Lord Windsor's Committee last year. At White Hart Lane the London County Council had a building estate. Counsel then read extracts from the report of the Joint Committee on Tube Railways of 1901, which recommended the construction of tubes from the centre of London to the suburbs, showing that the Committee considered that the line, which as then proposed, went only as far as Seven Sisters Road, would relieve the congested population. Continuing, he said, that it was most desirable that they should spread the population of the districts over a larger area. He would be able to bring forward evidence to show how crowded the population was. The population of the City of London had decreased from 37,702 in 1891 to 26,897 in 1901. On the other hand, the outer zone of London, consisting of 14 Borough Councils, had increased in population from 1,188,447 in 1891 to 1,771,677 in 1901. Statistics of the number of passengers carried by the various railways, tramways, &c., were then given. The population along the proposed line was remarkable. The average number of persons to the acre in London was 60·6 in 1901, and as showing the overcrowding in the various districts along the line, he said that the population of Shoreditch was 184 to the acre, and that of Whitechapel 213·6 to the acre. There was a great deal of land which could be developed round the district of Epping Forest, and he contended that the Great Eastern could not deal with the great overcrowding which existed. In reply to a question by the chairman, counsel said that they proposed to establish a connection with the Great Eastern at Liverpool Street by means of a subway from their own station at Liverpool Street. It was found, however, that no such subway was shown on the deposited plans. Continuing, when they were in Parliament in 1901, the Great Eastern woke up to the fact that something should be done, and a map was then shown, on which were green lines representing railways which the Great Eastern proposed to construct to serve the district, but as most of the lines, which were proposed to be of tube construction, and worked by electricity, ran under the Great Eastern's existing railways, they would not have served any new district. Lord Claud Hamilton, in a speech last year, had, so far from advocating that any provision should be made to relieve the congested traffic, said that the company should "sit tight and watch events." The company was still sitting tight, and, added counsel, so were the passengers—19 in a carriage. Dealing with the petitions of the Great Eastern and the North London Railway, he said that the opposition was merely against the competition of the proposed line. The London County Council, who had the building estate at White Hart Lane, had last year approved generally of the line, as also had the Corporation, he believed, with the exception of one station, which he would deal with later on. Referring to the Board of Trade regulations, counsel said that they had a clause in the Bill, the effect of which would be that if, at the end of a year, the progress made with the construction of the line was not satisfactory to the Board of Trade, then the powers given them by the Bill should cease. The traction would be on the multi-motor principle, and the size of their tube would be 12 ft. 6 in., the size which was suggested by Major Yorke. There would be a confluent junction at Hackney Road, and it was quite true that the Joint Committee considered that confluent junctions should be avoided, not only in tube railways, but also on railways above ground. In their case, however, there could be no possibility of danger. There was an automatic arrangement by which, should a driver disregard signals, his train would be shunted into a siding. With regard to objections taken by property owners, there was a clause in the Act which would protect and compensate owners for any damage due to vibration from the railway or the lifts. In reply to the Chairman, that clause would apply to property at any distance from the railway, if it could be proved that such property had been damaged. With regard to the Corporation of London, he believed they were in favour of the Bill, and had passed, on the recommendation of their Street Committee, a resolution that the Bill be generally approved, but stating that their opinion was that there should be no junction of tubes under the Hackney Road. The Corporation also required that the company should deposit the sum of £20,000. There was a question of whether there should be two or three stations in the City, and in that matter they would be prepared to come to an agreement with the Corporation. The station at Threadneedle Street they would surrender if the Corporation desired, but if it had to be constructed, it would have to be under the roadway. With regard to the finance of the railway, he would be able to bring evidence to show that so much of the line was to be constructed in the open that it would not be so very expensive. It was when they came to the tunnelling under the roadways, &c., by shields, that the expense would increase. Part of their financial support would come from America. The capital would be £4,500,000 in shares and £1,500,000 borrowing powers.

On 2nd inst. Mr. S. F. Ridley, M.P. for the South-west Division of Bethnal Green, was the first witness called in support of the measure. He said that that area had a population of 65,000. Most of them were engaged in business in the City during the day. The proposed railway would be of great benefit to them.

Cross-examined by Mr. Pember, K.C., for the Great Eastern Railway, he could not say exactly how many of the 65,000 came to the City. The main advantage of the proposed line would be that passengers would be carried right on to the Monument.

Mr. Pollock, K.C., who appeared for the L.C.C., questioned witness as to the necessity of cheap tickets for workmen. In reply, Witness said he would like to see cheap workmen's tickets issued over the whole of the line.

Mr. Moon, K.C., for the North London Railway, Lord Robert Cecil for the Colonial Bank, and counsel for other banks in proximity to the proposed station at the corner of Cornhill cross-examined witness.

Witness said that the Great Eastern Railway Co. and the tramway companies were not able to accommodate the great stream of people which flowed into the City every day. Crowds of people who could not get into the trains and trams could be seen every morning walking into the City down the Cambridge road and Shoreditch High Street.

Mr. Courtenay Warner, M.P. for the Lichfield Division, and a large owner of property at Walthamstow, was next called. He said that it was quite true that the Great Eastern charged only 2d. as far as Wood Street, but beyond that that company had no workmen's fares. In reply to the chairman, witness said that the flats and dwellings which had been built on his property had accommodated over 15,000 persons. There was a considerable amount of land yet to be built on, and it was in districts not yet adequately served by any railway. The proposed line would serve those districts.

Cross-examined by Mr. Rigg for the Corporation of London: He was aware that the Joint Committee of last year had reported unfavourably on confluent junctions.

Mr. David John Morgan, J.P., and M.P. for Walthamstow, said that on several occasions he had communicated with the Great Eastern Railway Co. with regard to the overcrowding on that line. He thought that the Great Eastern had done all it could in the matter. He had had personal experience of that overcrowding. On one occasion recently the only accommodation on a journey to Walthamstow was in the guard's van, and there were 42 persons in that. The new line was desired very much for the workmen's trains. That was the feeling in Walthamstow. The proposed line to Waltham Abbey passed through land which would be very valuable when developed for building. It was very desirable to get people from the districts nearer London out to the country where rents would be cheaper.

Cross-examined by Mr. Pollock: He thought that the time up to which workmen's tickets were issued in the morning might very well be extended from 7.30 to 8 o'clock.

Mr. A. Allhusen, M.P. for the Central Division of Hackney, cross-examined by Mr. Pollock, said that if any encroachment were made upon Hackney Marshes, an open space under the control of the L.C.C., other land should be given by way of recompense.

Mr. William Eve, an alderman of Stoke Newington Borough Council, also gave evidence as to the overcrowding on the Great Eastern.

Sir M. M. Bhownaggree, M.P. for the North-East Division of Bethnal Green; Mr. Slade, of Messrs. Protheroe & Morris; and Colonel Richard Colville gave similar evidence as to the necessity of the railway.

Colonel Lockwood, M.P. for Epping; Colonel T. H. Robertson, M.P. for South Hackney; Mr. Morris, member of the Essex County Council; Mr. Walter Hasemer, member of the Hackney Borough Council; Mr. Wragge, vestry clerk of Leyton, also followed on the same lines.

On 3rd inst. Mr. Wragge continued his evidence, and was cross-examined by Lord Robert Cecil for the Colonial Bank.

Mr. William Beck, chairman of the Urban District Council of Waltham Cross, said that the proposed railway would be of great use to the inhabitants of the district. He had taken the chair at several public meetings of ratepayers when resolutions were passed in favour of the Bill. On the eastern side of the Lea Valley there was a large amount of land suitable for building, but it had not been developed, as there was no direct communication with London.

Mr. Bousfield, K.C., M.P. for North Hackney, gave evidence as to the inadequacy of the present railway communication with his constituency. There was great overcrowding in the district also, and this would be relieved by the diffusion of the working classes further into the country. The proposed line would also be of great value as a means of communication with London. The whole constituency was in favour of the project. He had frequently noticed that it was more difficult to get from North to South of London than it was to get right away into the country. Any line which afforded direct communication with the City, whence there was communication in all directions, will be of great benefit.

Mr. Claude Hay, M.P. for the Hoxton Division of Shoreditch, said that there was a great tendency in his division to supplant house property by large manufactories and warehouses, consequently driving the people out into the suburbs. The alien immigration also tended to influence the English population to move away from the district. It was true that there were railways passing through his district, but they were all overcrowded.

Cross-examined by Lord Robert Cecil: It was desirable that the proposed line should have communication with the Central London. If the loop line proposed by the Central London were not passed there would not be any direct communication.

What is the urgency in getting this line past Liverpool Street? Why should that part of the line not be postponed until after the decision of the Royal Commission?—He thought it was necessary to bring people into the City. He thought that the present Bill was more favourably considered than were the previous Bills.

Mr. Joseph Howard, M.P. for Tottenham Division of Middlesex, Mr. W. R Cremer, M.P. for the Haggerston Division of Shoreditch, gave similar evidence.

Mr. Dickson, the engineer surveyor to the Metropolitan Borough of Shoreditch, said that his Council had settled with the promoters the sites of the different stations in that district. It was at his suggestion that the stations were placed under the roadway. With regard to the alien population, Witness said that several firms had lost their English workmen, as the men could not find house accommodation.

Mr. Scorgie, borough surveyor of Hackney, gave evidence as to the overcrowding in that district. It was entirely due to the want of facilities for getting into the country that so many workpeople crowded together and paid high rents for houses in his district.

Mr. Goode, chairman of the Walthamstow District Council, having given evidence, the Committee adjourned until Wednesday, April 22nd.

London County Council (Tramways) Bill.—The North Metropolitan Tramways Co. have withdrawn their opposition to this Bill.

Great Northern, Piccadilly and Brompton Railway (Various Powers) Bill.—Thursday, April 23rd, has been fixed for the consideration by Mr. Compton Rickett's Committee of this Bill.

Metropolitan District Railway (Various Powers) Bill.—The promoters have given notice of objection to the *locus standi* of the Westminster Electric Supply Corporation, the Metropolitan Railway Co., the London County Council, and the London and North-Western Railway to appear in opposition to this measure.

New Group.—A Select Committee, with Mr. Kearley as Chairman, has been appointed to consider the following Bills on April 28th:—London, Tilbury and Southend Railway, Metropolitan District Railway (Various Powers), London United Tramways, L.C.C. Tramways and the Romford and District Tramways.

Birmingham District Tramway Bill—The Standing Orders Committee of the House of Commons reported on Wednesday last week that in the case of the above Bill the Standing Orders ought to be dispensed with, and that the parties be permitted to proceed with their Bill, provided that the powers to construct tramways Nos. 1, 1a, 2, 3, 4, 5 and 6 be struck out, unless the consent of the County Councils of Warwickshire and Worcestershire be proved before the Committee on the Bill.

The Birmingham Corporation have deposited a petition in the House of Lords, praying to be heard against the Bill.

SOME EXPERIMENTS WITH AN EXTRA HIGH-TENSION FUSE.

By DR. C. C. GARRARD.

There is no doubt that the result of experience gained with circuit-breaking devices for the protection of E.H.T. transmission cables is that only those of the oil type are to be considered safe, and to be relied upon to fulfil their duty properly. The circuit-breaker may take one of two forms, viz., automatic switch or fuse. The latter has the inherent advantages over the ordinary form of automatic circuit-breaker of simplicity, and that it introduces the time-element principle. If a short-circuit occur, and be merely temporary, it is manifestly unnecessary and disadvantageous to interrupt the circuit. The fuse requires a definite time interval to elapse before sufficient heat can be generated to melt it, whereas a circuit-breaker of the ordinary type would act under these circumstances almost immediately. Time-element relays in connection with automatic switches, necessitating clockwork and such like gearing, are not desirable features in switchboard work. Makers have also found it difficult to work the tripping mechanism of an automatic switch by means of the alternating current itself, and when direct current tripping magnets are employed the additional chance of failure of the direct current is present. When, as is presumably the case, the transmission line is protected in no other manner, the failure of the breaker is, of course, a very serious matter.

As regards oil fuses, doubts have been raised as to the possibility of designing them for 10,000 volts, and in a recent issue of this Journal, Mr. A. C. Eborall says: "A fuse cannot be made in such a way as to open a 10,000-volt circuit (with a large amount of power behind it) under all conditions with certainty and safety." This is, however, an erroneous conclusion, as the following will show.

The fuse experimented on is shown in fig. 1, and has recently been placed on the market by Messrs. Ferranti, Ltd., being essentially a development from their smaller standard oil fuse, but modified to suit the increased pressure, 11,000 volts, and large power, 1,500 kw., for which it is designed. The fuse pot is 18½ in. high, and consists of a porcelain vessel divided down the middle by a partition.

Over this division hangs a porcelain saddle, A, with projecting cross-pieces, which divide the whole pot up into eight compartments. There is no lid, the pot being open to the air; neither is any gear arranged above the fuse. The current is led in and out by the contacts, B, B, which make metallic connection each side to a spindle, on which are four drums wound up by steel spiral springs fixed inside them. The flexibles which reach through the oil to the top of the middle

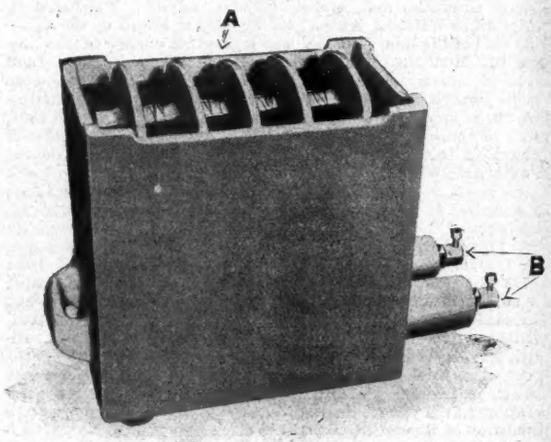


Fig. 1.—Ferranti Extra High-Tension Fuse.

partitions, are fixed to the outside of these drums, and when pulled to the top wind up the springs. The copper fuse wires, which are about 1 in. long, are soldered to the ends of these flexibles. On the fuse wires melting the flexibles are drawn sharply down into the oil by the springs inside the drums and the arc is extinguished on the top of the oil. The effect of the arrangement is that there are four fuses in parallel, and this is one of the secrets of the successful operation of the apparatus. The spindles, together with the drums, springs and flexibles, are easily removed for inspection or repair by unscrewing three small screws, and they are as easily put back again.

By kind permission of the Metropolitan Electric Supply Co. some tests were made on this fuse at the company's generating station at Willesden. The plant used was the Sülzer-Kolben 5,500-h.p. two-phase 11,000-volt set. The fuse was connected in series with an oil-break switch across one phase of the generator. With the generator running at full speed and voltage the switch was shut so that the fuse made a dead short across the machine terminals. The pot was fused up to and including 14 strands of No. 26 L.S.G. copper wire, which would correspond to a normal carrying capacity of 250 amperes. In each case the circuit was broken admirably. A loud report was heard, and a cloud of smoke shot up into the air. Resin oil was used, and this was found to be very little carbonised. No deposit of carbon was made on the outside of the pot, and only a very little on the dividing saddle. At the instant of breaking a bright flash on top of the oil was noticed, but the current was broken instantaneously. Practically, no oil was spilled, but just a little was projected out in the form of small drops.

On examining the pot after each fuse had been blown, it could be easily seen how the flash had been totally confined to one of the four parallel fuses. The wires in the other three were broken cleanly in the middle, as though they had been cut with a knife, but those of the remaining one had totally disappeared, and sometimes a piece of the small hook at the end of the flexibles, to which the wires are soldered, had been fused away also. A little consideration will show that this action is highly advantageous. The size of the arc

which is required to be damped out by the oil is, *ceteris paribus*, proportional to the amount of vaporised metal contained therein. If now all the fuse wires were bunched together, all of them would be vaporised, whereas here only a quarter of them are, and the arc is proportionally smaller and easier to damp out.

The flash was not always confined to the same pair of flexibles, and the order in which the four fuses went seemed to depend on a variety of circumstances. The above tests were repeated a number of times with the same good result. No damage was done to the porcelain pot. Where the flash occurred the porcelain saddle piece was generally a little scorched, but this was of no consequence.

It must be understood that these tests were very severe ones. They show that a multiple oil break fuse, constructed on the lines of the one tested, is a reliable means of protection for cables up to any voltages or powers likely to be met with in this country. The writer would express his indebtedness to Mr. Knight and Mr. Markby, of the Metropolitan Electric Supply Co., for their kind assistance, which enabled the above tests to be carried out.

INSTITUTION OF ELECTRICAL ENGINEERS.

ON ELECTRONS.

By Sir Oliver Lodge, F.R.S., Vice-President.

(*Paper read in London, November 27th*, 1902.)

(*Continued from page* 548.)

On Chemical and Molecular Forces.

The force of chemical affinity has long been known to be electrical. Ordinary electrical attraction between charged bodies may be called molar-chemical action; only there is no combination in ordinary cases, because the opposing charges spark into one another, and so the attraction ceases when a certain proximity is reached. The idea that chemical forces are really electrical is as old as Sir Humphrey Davy.

Real chemical attraction occurs between two atoms, each of which contains an odd number of electrons: one extra, or it may be more than one extra, electron of given sign. Such an atom has a centre of force whereby it can attach itself to other atoms and enter into pairing or chemical combination with them. It is probable that a negative charge is an excess, and a positive charge a defect; and that when pairing occurs the excess charge of one fills up the deficiency of the other, and composes a complete and neutral molecule.

Union of this kind, however, never seems quite as strong and permanent as the union of the electrons in the atom itself; the molecule easily separates at the same place again under the influence of decomposing influences, and does not seem able to split up in other ways into new substances; except in organic chemistry, where various modes of splitting up a complex molecule can be brought about, and are practically utilised for the generation of new compounds, *e.g.*:—

$$CH_3 \,.\, CH_3 = C_2H_6 \,.\, H.$$

It is probable that the same sort of thing is *possible* with simple bodies, but that the so-called "elements" constitute a peculiarly stable group, the ingredients of which so far have only partially been reassociated into isomeric or allotropic forms, and have not yet been detached from each other.

When chemical combination occurs between two oppositely charged atoms, there is no electric discharge between them: the two atoms retain each its own charge, and cling together for that reason. When they are separated, each is an ion and possesses its appropriate charge.

It is possible to charge an assemblage of neutral molecules with an excess or with a defect of one or more electrons, by processes of ordinary electrification, but the attachment of these supernumerary electrons is loose—and they can be shaken away by the agitation of ultra-violet light and in many other ways. Even splashing of liquids into spray shakes some loose.* And in the case of massive molecules their mutual collision or agitation under the influence of ordinary temperature is sufficient to shake away some of the loose electrons, which then fly off tangentially with whatever orbital velocity they may have had: giving rise to phenomena recently discovered under the name of *radio activity*.

Molecular Forces. Cohesion.

But there is another kind of adhesion or cohesion of molecules, not chemical, but what is called molecular. This occurs between atoms not possessing ionic or extra charges, but each quite neutral, consisting of paired-off groups of electrons. At any moderate distance the force of attraction between paired electrons will be next to nothing, but at very minute distances it may be very great, ranging up to something almost indistinguishable from chemical combination, except that the cling will be a weak cling at a multitude of points instead of an intense cling at only one.

Consider the outer surface of an atom consisting of a regular group of interleaved electrons of alternately opposite sign. Its equipotential surfaces will be dimpled or corrugated or pimply sheets, which at a little distance away will be almost plain, the dimples increasing rapidly in depth and becoming like the cover of a mattrass when something less than molecular distance, something approaching the internal electron distances apart, is reached.

Two such atoms will, therefore, tend to settle down with their equipotential surfaces adjusted into uniformity, the pimples of the one fitting into the hollows of the other; and this is the state of things suggested by the facts of cohesion (fig. 5).

To investigate the actual law of force would be difficult, and too many assumptions would have to be made for the geometrical arrangement of the electrons in the adjacent atoms; it could only be approximate, because we should probably, at least in the first instance, have to assume a static distribution. Nevertheless, the attempt might be instructive, and might, in a developed form, be suitable for an Adams Prize Essay.

It is quite plain, however, that the result would be a force rapidly increasing and becoming great at small distances, and practically nil at any perceptible distance.

Molecular forces on this view are electrical, just as much electrical as are chemical forces; but they occur between chemically saturated molecules, and are due to the interaction or distant influence of paired electrons on each other across molecular distances.

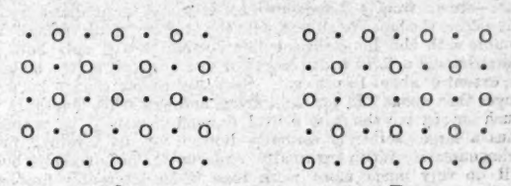


Fig. 5.—Ordinary cohesion between two neutral atoms A and B: each atom consisting of interleaved electrons of opposite sign, depicted in any convenient way.

Ions cannot thus combine; because, if they were oppositely charged, their combination would be chemical, and if they were similarly charged they would strongly repel each other.

But if ions arrive at a metallic electrode, or are provided with other means of passing on their free charges, they cease to be ions, and then they can and do combine molecularly with each other.

It is, of course, possible for an ion to have more than one free electron, forming a dyad or a triad radical; and the way in which a neutral group can receive and by rapid re-adjustment pass on an extra foreign electron, reminding one of the re-adjustment of the films in a lather when one compartment bursts, is doubtless instructive.

The effect of electric polarisation on such a neutral group of electrons is noteworthy. The effect of a charged body in the neighbourhood is at once to disturb the equilibrium and to disturb the grouping throughout the atom more or less: it will cause the negative electrons to protrude slightly on one side and the positive on the other (see fig. 6).

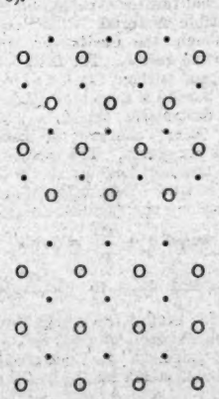


Fig. 6.—Two polarised atoms, polarised in different ways! illustrating also electrically intensified cohesion.

If two molecules were beyond each other's molecular range, and if the neighbouring surfaces could by any means, by the supply of electricity from without, be oppositely electrified, the forces of cohesion would be intensified momentarily by something akin to chemical forces, and cohesion would set in over ultra-molecular distances. This appears to be what goes on in a "coherer." The opposite charges cannot be *maintained* electrostatically between two neighbouring metallic surfaces, but they can be imparted with a sudden jerk or disruptive discharge or received electric impulse; and these are the things which are effective in promoting cohesion.

In the diagram herewith, fig. 5 represents a couple of atoms with

* Lenard on electrification near waterfalls.

interleaved electrons of opposite sign in square order, the atoms being within range of one another, and so cohering by molecular or non-chemical forces. They have adjusted themselves into a cohering position; but a shear through half the distance apart of the electrons would disintegrate them. An angle represented by half the electron-distance divided by the molecular-distance is, therefore, a measure of the maximum distortion of a substance.

Fig. 6 shows a couple of atoms both electrically polarised, as by a positively charged rod held above both. The constituents of C are polarised into hexagonal order—an effect such as might also be caused by lateral pressure in some cases; the constituents of D are in diagonal square order: which has the effect of violent electric polarisation. The atoms C and D are, therefore, clinging by forces much stronger than ordinary cohesion at that distance would have been. They represent adjacent atoms of a momentarily polarised coherer.

It is not to be supposed that the electrons need really ever be disturbed more than an almost imperceptible amount in order to produce this chemical cohesion effect.

(To be continued.)

BOILERS WITH EXTERNAL FURNACES.

Recent experience with refuse destructors tends to show that refuse burnt in a destructor furnace will produce as much—if not more—steam from a Lancashire boiler as can be produced from it when using the best Welsh coal, with the ordinary grate surface. The trouble with the Lancashire boiler is, that it will only hold fire grates having a joint width less than the diameter of the boiler to the extent of about 18 per cent. Such fire grates cannot be made longer than about 7 ft. for hand firing, and even this length is too much for any but the most skilful fireman to attend to properly. Thus a large boiler is seriously limited by its internal firing arrangements. When externally underfired, the Lancashire boiler will do very much more work than when internally fired, and its furnace can be more easily arranged to give more perfect combustion, but external firing is condemned by the boiler insurance companies, and is certainly not advisable when bad water is used.

There is, however, no reason why the Lancashire boiler should not be fired with coal in an external furnace, the products of combustion passing into the tubes as in the case of a destructor installation. The external grate may be made large, and, where boilers are not set up close to other boilers, they may be made to extend laterally in such a manner that the fireman throws in coal in a direction athwart the longitudinal centre line of the boiler. Such a furnace could be double-ended if necessary; or there might be two grates at different heights. The external furnace could be arranged so that the products of combustion all passed along one furnace tube and returned by way of the other. In ordinary practice, all furnace products pass over the bridge in a space less than half the tube area. With the bridge removed, the wheel draught described might be employed.

The entire absence of smoke which a rational system of firing would ensure, might enable the use of appliances for assisting heat absorption. Thus the employment of fins or gills in the furnace tubes would add greatly to the efficiency of heat absorption. If a Lancashire boiler will evaporate so much water as is claimed, namely, over 1,600 gallons per hour by means of the gases from a destructor, it is rational to suppose that it would do the same with any other good external furnace capable of dealing with a sufficient amount of combustible material. The absorption capacity is evidently there, though the credit for the results has been apparently given to the refuse. The fact, however, that such stuff as refuse can be burned without fume or smoke is simply a proof that all fuels can be burned if a genuine attempt be made to do so.

As regards refuse destruction, this is easy enough to carry out in uncooled furnaces. What combustible there is contains 14,500 British thermal units per pound. The specific heat of the dry parts of the refuse which are not combustible is about 0·25. Say one-fifth of the refuse is true combustible, demanding 20 times its weight of air. Then for each pound of refuse the total products of destruction will weigh $1 + \frac{20}{5} = 5$ lbs. Amongst the 5 lbs. there are $\frac{14,500}{5}$ thermal units to distribute, or 580 units per pound. As the specific heat of the whole is 0·25 or less, the temperature of the whole products of combustion must be 2,320° F., a temperature amply sufficient for destruction, and if properly applied, for just so much steam raising as the combustible is worth.

W. H. B.

BUSINESS NOTES.

Belliss Engines.—The Electrical Co., Ltd., has ordered from Messrs. Belliss & Morcom a 1,100-H.P. engine for direct coupling to A.E.G. alternator for the Sunderland Corporation. The Electric Construction Co. has ordered from the same firm one 585-H.P. engine for direct coupling to an E.C.C. alternator for Woking.

Switzerland.—The Aluminium Industrie Gesellschaft, of Neuhausen, is declaring a dividend of 15 per cent. for last year, as compared with 13 per cent. in 1901.

"Slipcure."—This is the name of a composition which is being supplied by the Indurated Pulley Cover Co., of 12, Paul Street, E.C. It is a pulley-covering composition which may be applied with a brush, and on hardening produces a (comparatively) rough cement-like surface, which its advocates claim is an antidote for the frequent slipping which occurs between belt and pulley. If effective it is certainly a far more desirable means—to the end—than the application of resin and similar substances.

Liquidation Proceedings.—A winding-up order having been made against H. M. Salmony & Co., Ltd., New Compton Street, W., the statutory meetings of the creditors and shareholders were held on Tuesday, March 31st, at the Board of Trade offices, Carey Street, Lincoln's Inn Fields, W.C. Mr. H. H. Wells attended for the Stewart Electrical Syndicate, creditors for £318. The chairman reported that the company was registered on March 16th, 1898, to acquire and carry on the business of H. M. Salmony & Co., electrical apparatus merchants, formerly carried on by Henry Max Salmony and Ernest Rosenberg. The nominal capital of the company was £25,000, divided into 5,000 5 per cent. cumulative preference and 20,000 ordinary shares of £1 each. The purchase contract was dated March 28th, 1898, and was entered into between Messrs. Salmony & Rosenberg as vendors of the company. It provided for the sale to the company as from January 1st, 1898, of the vendors' business as a going concern, together with all goodwill, patents, trade marks, fixtures, plant, machinery, &c., lease of premises at 118, Charing Cross Road, and all book and other debts due to the vendors, subject to payment thereout of debts and liabilities of the vendors in connection with the business. The consideration was agreed at £19,000, payable as to £7 cash, £11,993 in ordinary shares, £5,000 preference shares, and £2,000 debentures. The whole of the consideration was paid to Mr. E. Rosenberg in accordance with the written request of Mr. H. M. Salmony, dated October 18th, 1898. The contract further provided that the vendors should subscribe for or procure the subscription by responsible persons on or before May 1st, 1898, of shares or debentures for £8,000, in the proportion of £1,000 Mr. Salmony and £7,000 Mr. Rosenberg, in order to provide the company with working capital. The company further agreed to defray the promotion expenses. On March 28th, 1898, debentures were allotted for cash to nominees of Mr. Salmony £1,000 and Mr. Rosenberg £5,000, in accordance with the terms of the purchase contract, and further debentures for £2,000 were issued to the vendors in part payment of the purchase consideration. The total amount of debentures issued by the company, according to its register of debentures, was £7,900. In August, 1899, £1,000 debentures were paid off, and in the following November a further £1,000 were redeemed, leaving £5,900 outstanding. In June, 1899, the board resolved to dispose of the accessories and fittings portion of the company's business, and on July 5th, 1899, they agreed with Messrs. Rawlings, of 82, Gloucester Road, S.W., to sell that portion upon a valuation of the stock, &c, receiving between £7,000 and and £8,000 in respect of such sale. Mr. Alcock and Mr. J. E. Preston, the company's accountant and electrical engineer respectively, subsequently acquired Mr. E. Rosenberg's interest in the company, and became managing directors thereof at a salary of £350 each per annum. Further capital which they expected to be able to introduce was not forthcoming, owing, it was alleged, to the previous mismanagement of the company's business by Mr. E. Rosenberg, but the £4,500 debentures transferred on that gentleman's behalf to Messrs. Alcock & Preston were cancelled, and the company released from all liability in respect of them. The company was without working capital in February, 1902, and a loan of £225 was advanced by a Mr. Connolly, who received, as security, goods to the value of £315. That loan had not been paid off, and it was understood that Mr. Connolly was gradually disposing of the goods. A further loan of about £56 was obtained from a firm of auctioneers, the security being goods which were sold to them at a low price, they agreeing to resell them to the company at a profit of 5 per cent. Goods to the extent of £170 were also deposited with the Stewart Electrical Syndicate against the company's indebtedness to it, in consequence of the syndicate refusing to execute further orders unless its account was to some extent satisfied. On May 16th, 1902, proceedings for the appointment of a receiver were instituted in respect of debentures for £1,400, held on trust for Mr. E. Rosenberg, which security, it was alleged, was in jeopardy owing to the action of the company in disposing of its assets in the manner before mentioned. An order was made by the Court on May 23rd, 1902, restraining the company from disposing of its assets until the hearing of a motion for the appointment of a receiver. Three days later the company issued a writ against Mr. E. Rosenberg to recover £2,658 in respect of a loan of £10 and £2,648, alleged to be owing by him in respect of moneys overdrawn on account of salary as managing director. That debt was denied by Mr. Rosenberg, who further contended that one of the conditions upon which he entered into the agreement in January, 1902, with Messrs. Alcock and Preston was that he should be released from all liability in respect of any moneys owing by him to the company. On June, 1902, it was agreed between the parties that proceedings should be stayed upon the following terms:—

1. That the depreciation for £1,400 be transferred to the Stewart Electrical Syndicate in exchange for a debenture for £500 in that syndicate in favour of Mr. Hermann Schwabe.

2. That all claims of the company against Mr. Ernest Rosenberg be released.

3. That all the share capital of the company (with the exception of two shares) be transferred to the Stewart Electrical Syndicate; the consideration for such transfer to be £100 in fully-paid shares in

the Stewart Electrical Syndicate to be issued, 60 shares to Mr. E. Rosenberg, 20 shares to Mr. S. S. Alcock, and 20 shares to Mr. J. E. Preston.

On July 10th, 1902, a general meeting of the company was held, when the directors and manager of the Stewart Electrical Syndicate were appointed directors of the company. Since that date the company's business had been practically carried on and managed by the Stewart Electrical Syndicate, and had resulted, according to the statement of the secretary, in a small profit being made. According to a balance-sheet of the company prepared on September 30th, 1899, a loss of £7,766 appeared therein, as the result of carrying on the business for 21 months, but a sum of £14,257 0s. 3d. (the amount originally paid by the company for goodwill) was included in such balance-sheet in respect of goodwill, notwithstanding that a considerable part of the goodwill had been previously disposed of to Messrs. Rawlings Bros. The second balance-sheet was prepared on September 30th, 1900, and showed a further loss of £1,989 8s. 7d., of which £504 4s. 8d. was in respect of loss incurred up to September, 1899, and not included in that balance-sheet, the remaining £1,485 3s. 11d. being the loss on the year's trading. The amount in respect of goodwill was again taken into this balance-sheet at £14,257 0s. 3d., the sum originally paid for it. No further balance-sheets had been prepared. The petitioners were Messrs. Chauvin & Arnoux, of Paris, who obtained judgment against the company, and being unable to obtain satisfaction of the same, presented the petition for winding up. The failure of the company was attributed by the secretary to mismanagement on the part of Mr. Ernest Rosenberg, its former managing director. The company's assets, consisting of stock and book debts, were valued at £248, and were covered by the debenture for £1,400 held by the Stewart Electrical Syndicate; consequently there appeared to be no prospect of any return being made to the unsecured creditors, whose claims amounted to about £1,400, or to the shareholders.

Dr. Wells said, when the winding-up petition was heard, it was stated that the business was being carried on, and the judge made the winding-up order, believing that something would be realised through carrying on the business, but the effect of the order had been to ruin it absolutely.

The liquidation was left in the hands of the Official Receiver.

Appended is a list of the principal creditors, viz.:—

Unsecured.	
Bateman, M., & Co., London	£22 17 11
Crump, W. A., & Son, London	17 7 8
Campbell, A., London	29 8 0
Everett, Edgcumbe & Co., London	12 1 0
Helios-Upton & Co., Philadelphia, U.S.A.	48 0 7
Lingard, F. C., London	62 0 9
Rhenish Rubber and Celluloid Co., London	103 19 0
Rutherford & Co., Birkenhead	14 5 0
Stirling Supply and Manufacturing Co., U.S.A.	73 15 0
Schiff, Jordan & Co., Vienna	40 4 10
Statz, Paul, Stuttgart	50 0 0
Thompson, Wallsend	15 0 0
Young & Co.	21 17 6
Fully Secured.	
Loewe & Lydler, Moscow	170 3 0
Connolly, W., London	225 0 0
Ditto ditto	89 15 7
Partly Secured.	
Stewart Electrical Syndicate, Ltd., London	487 15 6
Debenture Holder.	
Stewart Electrical Syndicate, Ltd., London	1,744 11 8

The deficiency account is made up from March 31st, 1900, and is as follows:—

Deficiency as per statement of affairs			£19,586 13 9
Amounts extinguished:—			
Debentures	£4,500 0 0		
D. O. Rosenberg	2,665 0 0		
E. Rosenberg	1,000 0 0		
Modeira & Co.	8,588 8 9		
Schwabe	157 10 0		
Debenture interest	438 0 0		
		12,348 18 9	
Profit on sale of lease, as per books		550 0 0	
Creditors not expected to rank		331 6 9	
Total			£32,736 19 3

The above total is accounted for as follows:—

Excess of capital and liabilities over assets on March 31st, 1900			£8,805 7 5
Expenses of carrying on business:—			
Salaries and wages	£2,382 8 1		
Rent, rates and taxes	322 15 9		
Trade expenses	1,591 6 9		
Interest on loans	665 5 6		
		4,961 16 1	
Depreciation not written off in company's books on fixtures and furniture		278 7 3	
Ditto, goodwill		14,257 0 3	
Loss on gross trading from April 1st, 1900, to March 3rd, 1903		777 4 0	
E. Rosenberg, written off as per agreement, drawing account		2,929 8 1	
		£33,736 19 3	

At Warrington County Court on April 2nd an application was made to Judge Bowen Rowlands, K.C., for a compulsory winding-up order in respect of the Warrington and District Electric Light and Power Co., Ltd. The petitioning creditors were Messrs. Berry & Co., of Manchester, to whom the company owed £240 4s. 7d. Other creditors supported the application, which was granted.

At Liverpool County Court on April 3rd a petition was presented for the winding up of the Van Hinden Electrical Co., Ltd., of London. The company was formed in 1898, with a nominal capital of £1,000 in £1 shares. The amount paid up was £607. It was alleged that the company was insolvent and unable to pay its debts, and that, in the interests of the creditors, it should be wound up. Judge Shand made the order asked for.

Dissolution.—Messrs. M. & A. White (White Bros., electricians, of Sunderland) have dissolved partnership. Mr. Alfred White attends to debts.

The Witton Works of the G.E.C.—It has not taken long for the new engineering works of the General Electric Co., Ltd., at Witton, to secure a large quantity of important orders. The company has already secured many orders from over the sea, in addition to large orders for various industries in this country. The G.E.C. have recently received orders for generators to be direct coupled to the following engines:—

Bellis & Morcom.—Three engines, 120 B.H.P. each, for Pretoria workshops. One engine, 250 B.H.P., for Sir Joseph Causton's works. Four engines, 580 B.H.P. each, for New Kleinfontein Mines. All are for coupling to C.C. generators.

Allen, Son & Co.—One 700-B.H.P. engine for Bedford Corporation. One 200-B.H.P. engine for Borneo. Both for coupling to single-phase alternators.

Robey & Co.—One 23-B.H.P. and one 10-B.H.P. engine for coupling to C.C. generators.

Reavell & Co.—One 260-B.H.P. engine for Horsham, coupled to C.C. generator.

The following electrical plant is also in hand at Witton:—

For the Westminster Electric Supply Corporation.—Four motor-generators, each consisting of one 700-H.P. three-phase induction motor, 6,000 volts, 46 cycles, coupled to a 400-KW. C.C. generator.

To Admiralty Specification.—12 35-B.H.P. C.C. motors, and four 15-B.H.P. C.C. motors.

For India.—62 motors of various sizes.

Two 250-KW. three-phase generators, and motors aggregating 500 B.H.P., for a colliery near Birmingham.

One 150-KW. three-phase generator, and motors aggregating 160 B.H.P., for a colliery near Newcastle.

Two 200-B.H.P. three-phase motors for coupling to fans, for a colliery near Sheffield.

One 80-KW. C.C. generator and motors, aggregating 200 B.H.P., for New Zealand.

In addition to the above, upwards of 200 motors and generators of various sizes and types are going through the shops.

Nernst Lamps.—We have received from The Electrical Co., Ltd., a pamphlet containing a reprint of a report on the Nernst lamp, which it is asserted confirms the claims which have been made as to its durability, &c. The tests were made by Mr. E. E. Hoadley, borough electrical engineer, Maidstone. On January 22nd, at 1 p.m., three sets of quarter-ampere B type Nernst lamps were set to work on a 230-volt circuit. The results were as follows:—

I.	II.
1. Still burning after 971 hours.	1. Burnt out after 301 hours.
2. Burnt out after 961 hours.	2. Still burning after 971 hours.
3. Still burning after 791 hours.	3. Burnt out after 490 hours.
4. " " "	4. " " 574 "
5. " " "	5. " " 113 "
6. Burnt out after 168 hours.	6. " " 934 "
Average life so far, 886 hours.	Average life 575 hours.

III.	
1. Burnt out after 539 hours.	4. Burnt out after 754 hours.
2. " " 307 "	5. " " 380 "
3. " " 964 "	6. Still burning after 971 hours.
Average life 652 hours.	

The results are certainly an improvement on the averages of 305—450 hours given by Mr. Hammond and Mr. Stottner at the Institution of Electrical Engineers on February 26th last. We note, however, that in the matter of uniform life—a great consideration in street lighting—the results are still not all that could be desired.

Water Softener and Feed Water Heater.—We have received from Messrs. Arthur Koppel, of 27, Clement's Lane, London, a pamphlet descriptive of a new apparatus for the above purpose which this firm is putting on the English market. These softeners have been supplied, among others, to Messrs. Brown, Boveri & Co, the Union Electricity Co., Helios Electricity Co., Cologne Machine Works Co., Durr & Co., Cologne. The apparatus consists of a mixing and settling chamber (either cylindrical or rectangular in shape); mounted on this are the soda and lime solution tanks, above them being a small chamber containing an ingenious device operated by the incoming water, which automatically elevates from the lower chambers, portions of the lime and soda solutions, the rate at which these solutions are added varying with the rate of inflow of water. The apparatus is provided with a feed water heater operated by exhaust steam, and the water is further heated to a temperature of 175° F. in the mixing chamber, where the diffusion of the solutions is aided by means of a small live steam jet. An advantage claimed for the softener is the large filtering surface available, and also that the filters are removable without stopping work. The use of water softeners is being increasingly appreciated by a large section of engineers and owners who are compelled to use indifferent water, frequently in water-tube boilers and for many other trade purposes.

Trade Announcements.—Mr. P. Adler, electrical engineer, East London (Cape Colony), has disposed of his business to Messrs. A. C. Maytham & Co., and will in future devote himself entirely to the management of his King William's Town business.

The offices of the African Trans-Continental Telegraph Co., Ltd., have now been removed to 2, London Wall Buildings, E.C.

The Phœnix Dynamo Manufacturing Co., of Bradford, who recently purchased the works, business, patents, &c., of the late firm of Rosling & Fynn, have now removed from their Joseph Street works to their new works, and request that all inquiries, correspondence, &c., may be addressed to them at Thornbury Works, Bradford. They have already found it necessary to extend the

premises at Thornbury, which they are equipping with modern machinery, designed to further increase the company's output, and to enable them to give quicker deliveries of their specialities in which they have been so successful in the past few years.

Mr. Val. A. Fynn has opened offices at Royal Arcade Chambers, Manningham Lane, Bradford, where he will carry on business under the style of "Fynn & Co.," making a speciality of supplying complete and accurate working drawings, together with the fullest electrical data and all necessary diagrams for the construction of electrical machinery and apparatus of every description, for continuous or alternating currents, either single or polyphase. Mr. Fynn's practical connection with leading electrical manufacturing concerns, both in England and abroad, extends over the last 12 years. He will make a speciality of combination designs, such as motors coupled to tools, reduction gears, lifts, cranes, printing, dyeing and other machinery. Mr. Fynn's experience with polyphase plant and high tension power transmission has been extensive.

The N.S. Electric Storage Battery Co., Ltd., has removed its works from Greenwich to Horton Kirby, Kent, where all communications should be addressed.

The Electric Lighting Boards, Ltd.—In the Chancery Division on Monday, Mr. Justice Kekewich had before him the case of Brounger v. The Electric Lighting Boards, Ltd., on a motion for judgment. Mr. Waggett said this was a debenture holder's action. The plaintiff was the holder of debentures given to secure an advance. His Lordship made the usual order in a debenture holder's action, and directed the customary inquiries and accounts.

Oliver Arc Lamps.—Messrs. Oliver & Co., of Woolwich, have introduced a special open type arc lamp which renders itself particularly applicable for the lighting of comparatively unimportant thoroughfares by employing a considerably lower current than is usual. A contract for the supply of nearly 400 5-ampere arc lamps has recently been placed with the firm by the Bristol Corporation.

Catalogues and Lists.—A small catalogue of electrical machinery (No. 3) has been issued by Mr. T. W. Broadbent, of Victoria Electrical Works, Huddersfield. The manufactory has recently been largely extended to meet increased business The B H. generators from 1 to 120 kw., and motors of 1 to 150 h.p. are well shown, and prices are given in table form.

A good list of W.E. fan motors for 1903 has been brought out by the Western Electric Co. Desk, bracket and ceiling fan motors, both for direct and alternating-current circuits are very clearly illustrated by general and sectional views. Particulars are given of speed, voltage, dimensions, code words, and prices in every case. Accessories and parts are dealt with toward the end of the book, where, also, the code words are alphabetically arranged.

The Societe Alsacienne de Constructions Mecaniques Usine de Belfort, of Paris and Lyon, has sent us an illustrated list, showing its dynamos and motors with vertical axis for coupling to steam turbines.

The Dermatine Co., Ltd., of 95, Neate Street, Camberwell, S.E., is circulating a new price list of Dermatine. Some interesting introductory comments on india-rubber and gutta-percha lead up to Dermatine, which is claimed to possess most of the valuable characteristics of the best gutta-percha, and to be at the same time better able to stand extremes of heat and cold, and to be superior to rubber where flexibility without elasticity is a desideratum. A map is given showing the districts throughout the world where raw rubber is collected. Prices and particulars of Dermatine machine belting, also pump valves, packing rings, tubing and many other things made of this material, are set out in this catalogue.

Messrs. Ernest Scott & Mountain, Ltd, of Newcastle-on-Tyne, have sent us a batch of new price lists, which they have just issued from the press. These deal respectively with two-pole dynamos and motors, four-pole ditto, multi-polar ditto; vertical enclosed high-speed engines with and without generators coupled thereto; horizontal engines and crankshaft generators; three-crank compound engines and generators; double-cylinder, high-pressure high-speed engines. Other leaflets deal with field rheostats, also liquid and automatic starting switches. The lists are all excellently got up and well illustrated.

A new catalogue has just been published by the Rhodes Electrical Manufacturing Co., of 70 & 71, Bishopsgate Street, E.C. (and Bradford), giving full illustrated particulars and prices of their R E. type motors and generators, of which we gave a description in our issue of March 20th. The R.E. type has been adopted for direct-current motors, dynamos and back-geared motors from ½ to 40 h.p., and from 1 to 24 kw at various speeds.

The Lyle Co., Ltd, of Harrison Street, Gray's Inn Road, W.C., has sent us a copy of its latest catalogue, particularising the Lyle-Dossier file system for filing correspondence, catalogues, cuttings, &c., alphabetically, numerically and geographically. The system is very fully described and illustrated.

An abridged catalogue has been placed before us by Messrs. J. C. Lyell & Co., of 55, Victoria Street, Westminster. It gives a few details respecting many different lines of manufacture. Electric lamps and accessories for wiring, the "Hercules" storage battery, the "Hythe" automaton pumps, the Hythe electric motor-car, roller bearings and steam fittings are all briefly referred to.

The Dynamic Gas Power Co., Ltd., of 27, Clement's Lane, E.C., has sent us a circular showing a 50-h.p. Stockport gas engine worked by their dynamic gas producer at the Fulham Steel Works, S.W.

A list showing the Franklin patent ventilating frame and cover has reached us from Messrs. Rowland Cabb & Co.

An illustrated price list of fuse boxes of different types has been published by Messrs. Ernest F. Moy, Ltd., of Camden Town.

ELECTRIC LIGHT AND POWER NOTES.

Ashford (Kent).—The Empire Electric Light and Power Co., of Romford, has offered to lease the prov. order of the U.D.C., to pay a reasonable sum towards the expense of obtaining the order, and to consent to the Council purchasing the undertaking at stated intervals at a valuation as a going concern. The matter is being considered by a Committee. The Council recently decided to abandon the E.L. scheme.

Belfast.—Work in connection with the Queen's Island electric light and power plant for Messrs. Harland & Wolff's shipyard is proceeding rapidly. The excavations and piling—the latter costing some £10,000—is completed. The total cost of these works will exceed £100,000.

Berwick.—Permission was given to the Electric Supply Co., now preparing to introduce the electric light into the town, to lay their cables in the streets and roadways within the schedule. It was remitted to the Lighting Committee to prepare a comparative statement showing the cost of lighting the town by gas and electricity with a view to adopting the latter method.

Bexley.—The Foot's Cray U.D.C. had offered to accept an annual supply of electricity at a charge for the first 20,000 units of 4d. per unit, at 2d. per unit for the next 80,000 units, and 1·85d. per unit thereafter, but after the report of the engineers, the clerk was instructed to write that it was impossible to reduce the charges proposed by the Bexley authority without risk of loss; the rates as follows would at the most only allow a small margin of profit—4½d. up to 20,000 units, and 2d. thereafter.

Brighton.—A L.G.B. inquiry was held on Friday into the application of the T.C. for a loan of £1,500, to enable the voltage in certain parts of the borough to be changed from 230 to 460. The electrical engineer (Mr. Christie) in supporting the application, said that if the alteration was not made it would cost £5,000 or £6,000 to run two new feeders through the district. The only opposition was on the ground that the cost should be met out of the current expenses of the undertaking, and not by a loan.

Brighton Board of Guardians has decided to instal the electric light in the Elm Grove Workhouse.

Darlington.—At the meeting of the T.C. on April 2nd, it was stated that a profit of between £300 and £400 had been made during the year on the electricity works.

The T.C. has offered to supply energy to large works for power purposes at 1½d. per unit up to 1,250 units per quarter, and at 1½d. for more than that quantity.

Dumfries.—The T.C. has had under consideration and favourably commented on the following offer by the National Electric Wiring Co., Ltd., for lighting the burgh:—

1. The Council to borrow the capital required for carrying out any scheme agreed upon.

2. The company to carry out the scheme to the specification of the Council's engineer, or to prepare a scheme to be approved by the Council's engineer, and to carry out all work in connection therewith under estimate.

3. The undertaking to be run by the company in the Council's name, the company providing for, and guaranteeing, the payment towards sinking fund and interest, taking all profits when earned, with this proviso, that should the profits after providing for sinking fund and interest for the first 10 years work out at over 3 per cent. per annum on the capital expenditure, any excess profits would be refunded to the Council.

4. The Council to have the option of taking over the undertaking upon the expiry of 10 years, 12 months' notice of their intention to do so to be given, and if that option be not exercised then the undertaking to be taken over by the Council upon the expiry of 20 years. The profits on the undertaking for the last 10 years, after providing for sinking fund and interest and the 3 per cent. per annum to the company, to be divided equally between the Council and the company.

5. The price to be charged for energy not to exceed—

Private lighting—On the flat rate system 6d. per Board of Trade unit.

On the maximum demand system 7d. per Board of Trade unit for the first hour, and 3d. per unit for all energy consumed afterwards.

Power—3d. per Board of Trade unit for the first hour, and 1½d. per unit for all energy consumed afterwards.

Street and public buildings lighting—2½d. per Board of Trade unit.

Eastbourne.—It is proposed to apply to the L.G.B. for a loan of £10,000 to clear the present deficiency on the E.L. works and to provide working capital for extensions.

Falkirk.—A conference has been held, at which Mr. Harris, of the firm of Bramwell & Harris, electrical engineers, London, explained the proposed scheme of the Scottish Central Electric Power Order, for the purpose of supplying electricity, chiefly for power purposes, in the counties of Stirlingshire, Linlithgowshire and Clackmannonshire. The matter was under consideration at a meeting of the Falkirk E.L. Committee; it was decided to defer action till a copy of the order had been received. There is a probability of the order being jointly opposed by Falkirk, Stirling and Alloa, with the view to safeguarding their interests.

Farnworth (Lancs.).—Owing to the successful result of the first year's work of the Electricity Department, it has been decided to reduce the price of energy for traction purposes to 1d. per unit.

Germany.—A municipal central electric lighting station is to be established in the town of Olpe.

Hull.—A L.G.B. inquiry has been held into the application of the T.C. for a loan of £24,000 for E.L. purposes. The loan is required for the extension of the plant at the Dagger Lane substation and for new mains.

Halifax.—The T.C. is applying for borrowing powers to the extent of £20,000 for extensions to plant, &c. Among the items are: Motors, £6,000; switchboards, £200; boilers, £1,100; mains, £10,200.

Kent.—The Kent Electric Power Syndicate, Ltd., has obtained a provisional order in respect of the towns of Deal, Sandwich and Walmer, and is expecting to obtain other such orders in various districts.

Kirkcaldy.—The Kirkcaldy District Council of the Fifeshire County Council has resolved to oppose the Bill proposed to be promoted by the Fife Electric Power Co.

Leeds.—The T.C. intends to apply to the Local Government Board for sanction to borrow £220,000 for electric lighting and power purposes. The Council also approved the acceptance by the L. Committee of tenders amounting to £5,131 for works at the power station already approved.

Leigh.—The B. of T. has formally notified the U.D.C. of the revocation of the electric lighting prov. order.

London.—Westminster.—The City Council has agreed to a proposal by the Westminster Electric Supply Corporation that November 30th, 1902, be fixed as an average date from which the rebate of ½ per cent. per annum on all lamps should commence.

Islington.—It has been decided to ask the L.C.C. to sanction the borrowing of £4,125 for the purpose of providing 25 30-kw. transformers, with switch-boxes, &c., which are required for the purpose of meeting the demands of new consumers.

Marylebone.—It has been resolved that the Electricity Supply Committee be allowed to take counsel's opinion on the right of the L.C.C. to sanction the proposed loan, and that if the L.C.C. withholds its sanction, the said Committee be empowered to take the necessary steps to appeal to the L.G.B., or to obtain the sanction of Parliament.

Hackney.—The E.L. Committee, having considered the question of the supply of power on the day load to manufacturers, &c., in the borough, has resolved that an agreement be entered into with the Rhodes Electrical and Manufacturing Co. for the supply and fixing of motors on consumers' premises at schedule rates on the hire-purchase system; the agreement to be for a period of seven years, with the option of the Council to determine at the end of the third or fifth years.

Ludlow.—The T.C. has decided to engage an expert to advise them on the electric lighting question.

Merton.—As the result of an interview, the B. of T. has decided to embody in the prov. order being applied for by Wimbledon U.D.C. an express provision that the Croydon R.D.C. or the local authority for Merton for the time being shall be entitled at any time, on giving reasonable notice, to the transfer of so much of Wimbledon's undertaking as will be in Merton on terms to be arranged, or failing that, on terms provided by the Electric Lighting Acts.

Peterborough.—The T.C. is about to apply to the L.G.B. for a further loan of £5,000 for extensions to the plant at their electricity generating station, necessitated by the rapidly increasing demand. There will be a deficit of £121 on this year's working, but a handsome surplus is anticipated next year. The following estimate for new plant was sanctioned:—A generating set, £2,271; steam piping, £160; condenser and water pipes, £380; condenser pump and motor, £180; street arc lamps, £1,400.

Reigate.—The T.C. has applied to the L.G.B. for a loan of £8,165 for extensions to the electricity works and for the construction of an artesian well.

St. Annes.—The financial year ending March 31st, 1903, shows a surplus of £150, on the electrical undertaking. The average cost of production was 1·82d. per unit, against 2·39d. during the previous year.

Shrewsbury.—The Shropshire, Worcestershire and East Denbighshire Electric Power Co. having agreed to insert a clause by which the company would not, without the consent of the Shrewsbury Corporation, lay cable or supply energy in bulk within or to be used within the borough of Shrewsbury. It has been decided not to oppose the Bill.

Sleaford.—The L.G.B. has declined to grant a further loan of £2,000 for the extensions of the electric lighting installation until a public inquiry had been held. The expenditure had far exceeded the estimate of the committee.

Spain.—A central electric power station has lately been completed at Ameraun, energy being transmitted to Tolosa, a distance of 7½ miles, for lighting and power purposes. Water-power is utilised, the plant comprising two 600-h.p. turbines, each coupled to a 480-kw. three-phase alternator, running at a speed of 400 revolutions per minute.

Staffordshire.—The South Staffordshire Mines Drainage Commissioners decided last week that the £68,000 remaining of the loan sanctioned by Parliament 10 years ago should now be expended in clearing the Tipton mines of water. Steam, Mond gas, and electricity are to be used to drive the surface and underground pumps which will be laid down.

Stoke-on-Trent.—The R.D.C. has decided to obtain information as to the cost of obtaining a prov. order for electric lighting.

Sweden.—A central electric lighting station is about to be established in the town of Oxelosund.

Tunbridge Wells.—The T.C. has adopted a minimum charge of 5s. per h.h.p. per quarter for energy supplied to motors.

Dorchester.—The T.C. on April 2nd decided to engage a borough electrical engineer at a salary not exceeding £120 per annum, to carry out the electric light installation in the borough.

Winnipeg, Canada.—The City Council is considering the offer the Great Falls Power Co., who want the city to take 3,000 h.p. per annum for five or ten years guaranteed. It is proposed to charge $50 per horse-power per annum, which is said to be much cheaper than the present rates.

Yeovil.—The B. of T. has granted the T.C. a prov. order for electric lighting within the borough.

ELECTRIC TRACTION NOTES.

Alexandria.—The *Egyptian Gazette* states about 30 electric cars have now arrived at Alexandria for the Ramleh Railway Co., and four double-deck cars are now *en route*. The entire number of 54 cars will be there before the middle of April. Mr. Albanese, who has been staying at Alexandria as representative of the Electric Car Co., of London, which furnished these cars, has left for England. These are said to be the first electric cars imported into Egypt by a British firm. Every bit of them is of British make and design.

Birmingham.—The Tramways Committee last week considered an alternative offer from the B.E.T. Co., but considered it unacceptable, and adjourned further consideration until this week.

Bradford.—On April 1st further reductions in tram fares came into force in Bradford, one of the most notable effects of which is, that any passenger travelling from the centre of Bradford to Leeds before 8 o'clock in the morning can do so for a fare of 2d. A statement which has been issued re the tram traffic for the year ending March 31st shows that the miles run were 3,920,488, and that the receipts were £169,043 13s. 6d., amounting to 10·33d. per mile run. The receipts for the week ending March 29th last were £3,308, as against £1,936 for the corresponding week of last year.

Brighton.—The Chairman of the Tramway Committee says that already the sum of £3,051 5s. 11d., which was borrowed last March to make up for the deficiency of the first four months' working, has been paid back to the rates, besides which there is a surplus over, so that the tramway system is more than paying its own way.

Cape Colony.—Developments at the South-Western end of the Colony include schemes for the provision of electric tramways and power for the Paarl and for Somerset West, including a line from the latter point to the Strand, a favourite seaside resort under the Hottentots Holland.

Chester.—The electric tramway service was inaugurated on Monday last. It takes the place of the old horse-trams.

Colchester.—The T.C. has applied to the B. of T. for a loan of £61,164 for tramway purposes.

Elland.—The U.D.C. has decided to ask the Halifax T.C. to transfer to it the powers obtained by the Corporation for constructing electric tramways in the Elland District, and to release Elland from its obligations under the Act of 1900, obtained by the Corporation. The U.D.C. has already interviewed the B.E.T. Co. with a view to electric trams being provided and current obtained from the Council's works, thus creating a day load.

Gillingham.—The Lords Commissioners of the Admiralty (through the civil engineer at Chatham Dockyard) have approached the Gillingham District Council (Chatham) asking for the sanction of the Council to the construction of a tramway, in order to connect the new Royal Naval Hospital with the Dockyard. The matter has been referred to the Survey Committee.

Glasgow.—A special committee of the Corporation Tramways advises the T.C. to accept an offer by the General Accident Assurance Corporation, Ltd., for renewals of the accident insurance for the year ending May 31st, 1904, as follows:—(*a*) The company to grant a policy covering all claims for accidents to persons, or damage to the property of third parties, caused by the horses and vehicles belonging to the tramway department, or caused by any defect in the plant and permanent way of the department, as also all claims for personal injuries to third parties arising in or

about the buildings belonging to the department, the limit for any one accident to be £2,500, and the indemnity for the year to be £25,000; the premium for this insurance to be £15,000, with the proviso that if the car-mileage for the year exceeds 15 millions, an additional premium of 1s. per 100 car-miles is to be paid by the department; and (*b*) the company also to grant a policy insuring the department against claims under the Employers' Liability Act, the Workmen's Compensation Act, and at common law, at a premium calculated at the rate of 6s. per cent. on the wages.

Johannesburg.—The East Rand correspondent of the *African World* writes:—"It is understood that Percy Girouard and Mr. T. R. Price are considering an important change in respect to the East and West Rand railway services—nothing less than the running of all passenger trains by electricity. It is stated that the line is admirable suited to the purpose, and, seeing that coal can be obtained at very low price at the pit's mouth immediately alongside the line, the cost of power should be small. The generating station would naturally be at the colliery. If electric trains are adopted, it is probable that the present trains of seven or eight carriages running every hour will be changed into short electric trains with an half-hour or 20 minutes' service."

King's Norton.—At a meeting of the U.D.C. on April 2nd it was decided to lease the Pershore Road tramway extension to the Birmingham Electric Traction Co.

Kirkcaldy.—In his report Prof. Kennedy advises the Committee to allow the work of tramways extension to proceed under existing contracts, as if it were put out again the total loss in time could not well be less than three months, and it was not likely that any substantially lower price would be got, as the accepted tenders were the lowest in the original competition. The estimated capital cost of the single line extended route Prof. Kennedy gives as £28,489, with an additional £4,000 for plant in the generating station. Should the line up Whyte's Causeway be doubled, which he considered really desirable, the extra cost would be about £1,800, and if the rest of the line be doubled, the further additional cost would be about £7,000. The estimated annual expenditure on the new route was given at £6,693, and the income £7,446, giving a balance profit of £753, taking the receipts at 9d. per car-mile, the receipts not having yet fallen below 11d. per car-mile.

Liverpool.—During the recent race week the Liverpool tramways carried 2,054,644 passengers. The receipts were £10,114 against £9,515 last year. On the Grand National day 45 extra cars were put on, and the number of passengers carried on the Walton, Aintree and Fazakerley routes was 92,910 compared with an ordinary day's traffic of 36,200 passengers. The emergency calls for the three months of the year have numbered only 129 compared with 357 in the corresponding period of last year.

Luton.—The borough engineer recently made a brief report to the Tramways Committee on the cost of a tramway system. He has been asked to elaborate his report for circulation among the Council. The electrical engineer has also recently prepared a report, and this, too, is being printed.

Manchester.—The chairman of the Corporation Tramways Committee (Councillor Boyle) made, at the last meeting of the City Council, a gratifying statement with regard to the city tramway undertaking. On April 1st the Committee practically completed the introduction of electric traction upon the tramway routes within the city. It was only 18 months since the first electric car was run in Manchester. Having accomplished so much, Mr. Boyle said, they were going into fresh fields, and within a week cars would be running to the Stretford terminus, and also to the Chorlton Road terminus. Other roads were in process of equipment, including the cross route from Hyde Road *viâ* Kirkmanshulme Lane, Stockport Road, Dickenson Road and Oxford Street to Brooks's Bar. The route from Cheetham Hill by way of Queen's Road to the Harpurhey district would also be equipped so soon as some local street improvements now in progress admitted of it. A tramway would also be carried along Butler Street and Bradford Road to Philips Bank, with a return line to the city down Bradford Road and Union Street. Further extensions would be from Withington to Northenden, and from Brooks's Bar to Chorlton. The Committee were also under obligations to Denton to run to Haughton Green, and with Audenshaw to run to Guide Bridge. Through communication to Ashton-under-Lyne would follow, and also, it was hoped, with Oldham. In addition to these schemes, the Tramway Committee had considered the desirability of securing a through tramway route from Manchester to Altrincham. A cross connection between Northenden and Barton Bridge and the Eccles system was also desired. This would bring Manchester cars in touch with the Salford system, at its furthest extremity of the city. As a rule, Mr. Boyle added, local authorities preferred that any tramways passing through their districts should be worked by Manchester, but as the outer districts were less populous than those immediately adjacent to the city, the Corporation could not afford to give them the same terms.

Mersey Railway.—Early on Friday morning the Board of Trade inspection of the new electrical equipment of the Mersey Railway was made. A train of five cars was run between the stations, and a close examination of the signalling arrangements was made. The B. of T. were represented by Major Druitt, and with him were Mr. R. Bowman Smith, traffic manager of the railway, and representatives of the Westinghouse Co. The service will probably be formally opened in about a fortnight. Trial trips have been run regularly on the line in the early hours of the morning for some weeks past.

Oldbury.—The U.D.C. has consented to the application of the Birmingham and Midland Tramways Co. for an extension of time for a further year for the completion of the electrical equipment of the tramways.

Oldham.—The T.C. has passed a resolution calling upon the borough surveyor to resign his position. The borough surveyor has had charge of the electrical tramway undertaking in the town so far as laying the lines and track are concerned, and the action of the T.C. is in consequence of a report of a special committee appointed to inquire into the manner in which the undertaking has been managed. On the agenda for the same meeting was a resolution instructing the town clerk to apply to the L.G.B. for sanction to the borrowing of £104,533 to cover the extra expenditure incurred by the Corporation on the construction of the tramways, &c., but the chairman of the Tramways Committee withdrew it for the present.

Redcar.—The U.D.C. has asked the Imperial Tramways Co. to extend the electric tramway from Grangetown to Redcar.

Ripon.—The Light Railway Commissioners on April 2nd decided to submit an order to the Board of Trade for the construction, by the Power and Traction Co., of an electric tramway between Ripon station and the city, and on to Studley village. The scheme received support from the City and Rural District Councils.

Sale.—The election of members for the U.D.C. was fought entirely on the question of the contract of the B.E.T. One of the old members just retained his seat, whilst the second was defeated by a large majority. The feeling in the town is strongly in favour of annulling the contract if possible.

Salford.—Two new tramway routes connecting this borough with outlying districts to the West and North were opened last Friday. The first was to Swinton and Pendlebury; and the second to Whitefield through Prestwich. The districts served by these lines have large working-class populations, engaged chiefly in coal mining and cotton spinning. On each route the opening was made a matter of some ceremony, in which the authorities of the Borough, and of the several Urban Councils interested, took part. Decorated cars were run.

South Lancashire.—The Haydock—Hindley section of the South Lancashire tramways was inspected by Major Druitt, on Thursday of last week, and has since been opened for traffic.

Stoke-on-Trent.—The B.E.T. Co. has informed the R.D.C., who desired the extension of the electric tramways through the Bucknall district and the lighting of the district by electricity, that the directors do not think it desirable to promote further extensions of their system until the construction of those extensions which had been already authorised had been completed. They were also at present unable to make any statement with regard to the supply of current for lighting.

Tokyo, Japan.—A Sydney paper prints a Tokyo dispatch dated January 23rd stating that Sir Malcolm M'Eacharn, of Messrs. M'Ilwraith, M'Eacharn & Co., of London and Melbourne, had, acting on behalf of a British Syndicate, almost concluded an arrangement with the electric street railway of Tokyo, in virtue of the British syndicate was to supply the Japanese company with the capital it very badly needed.

Wallasey.—The U.D.C. is applying for power to borrow £24,500 on tramways account. Of this sum, £6,000 will be for additional cars at £580 each, and £7,000 will be on account of money spent on previous work. The Council have decided to increase the salary of Major R. R. Greene, tramways manager, by £100.

TELEGRAPH AND TELEPHONE NOTES.

Brighton Telephones.—The contractors for the street work, Messrs. Henley's Telegraph Co., are pushing on with laying the cable ducts, the Exchange buildings are nearly finished, and the Committee have notified all departments of the Corporation that the municipal system will be officially opened on November 1st (Sunday), and in consequence, notices have been served on the National Telephone Co. terminating the various agreements on October 31st.

Hull Telephones.—On Thursday last week the T.C. considered the tenders for establishing a municipal telephone service. An influential body of leading merchants had petitioned the Council to delay further steps until a ratepayers' meeting had been held to consider the proposal. A resolution that consideration of the minutes should be deferred was defeated by a majority of one vote. Alderman Crook then moved an amendment to the effect that, if the National Telephone Co. would agree to give a new rate of £7 to cover 1,500 calls per annum and to maintain such rate so long as the Corporation refrained from competition, the Corporation would permit the underground wires of the company to remain. The amendment was ultimately defeated by 30 votes to 19, and the minutes were adopted. Alderman Crook gave notice to move that the resolution should be rescinded.

London Telephones.—Last week Mr. Austen Chamberlain stated that the expenditure on the London telephone service to February 28th, amounted to £1,067,900. Seven exchanges had been opened since March 1st, 1901, and 8,749 telephones were now in use

in connection with these exchanges. About 2,000 agreements for other lines were on hand, and from 150 to 200 new lines were being brought into use every week. Four other important exchanges will be opened in the course of this year, and arrangements are in progress for the establishment of several others. In view of the increasing demand for new exchanges, and of the rapid development of the existing exchanges, it was not possible to name any date for the final completion of the Post Office system in London.

The Orling-Armstrong Wireless Telegraph and Telephone System.—The General International Wireless Telegraph and Telephone Co., Ltd., gave last Thursday a demonstration of the Orling-Armstrong apparatus in the grounds of the Alexandra Palace. The most spectacular demonstration was the exploding of two bombs from the Terrace, at a distance of about 700 yds. Two tuned transmitters were fitted on an ordinary table and connected through a two-way switch to two wires, each of which was connected to an earth plate buried at a depth of about 2 ft. in the ground, the plates being about 25 yds. apart. This forms the transmitting base, and for the best results should be $\frac{1}{10}$th of the distance of transmission. First one and then the other bomb were exploded, and it was shown to be impossible to explode the second with the same key as was used for the first. "In a state of warfare," asked our representative of Mr. Armstrong, "what is to prevent my transmitting waves, with a gradually increasing frequency, to your ammunition wagons and blowing them up one after the other?" "Only this," replied Mr. Armstrong, "that we have 3 million variations to choose from, and it would take you a long time to vary your frequency through that range." "What is your limiting distance of transmission, and what pressure do you use?" "We do not know the limit; the deeper our earth plates, the further we can transmit, and we shall shortly experiment from the bottom of the deepest coal pits in Staffordshire. Eight volts is the highest pressure we have used, and we have telegraphed 20 and telephoned 5 miles." "Does the nature of the ground affect your signals?" "Yes; and we have found out since fitting up our apparatus at the Palace here, that the oftener we signal, the better the results become. The waves appear to form for themselves a channel." "In effect, then, the earth appears to become polarised, like the molecules of a magnet, or the fibres of a violin, and the inference is that you can gradually increase the distance of transmission?" "Yes, that is so."

Connected to the same earth plates was a telephone, fixed in a silence box in the building. Another was similarly fitted in a sort of sentry box some 700 yds. away. Speech, Morse signals, and gramophone music were transmitted between them. Addressing Mr. Arnold White, one of the directors, our representative suggested that it would be more than interesting to see the actual earth connections.

Mr. Orling, "the Swedish Edison," thereupon took us to the spot and commenced to dig up the ground, much to the annoyance of Sir Jerrard Smith, the chairman of the company, who thought that his word was a sufficient guarantee that there was no metallic connection between the transmitter and receiver. An earth plate was, however, laid bare. To make the matter more convincing, two iron spikes were brought down and were driven into the ground at a spot we pointed out to a depth of about 2 ft. To these a telephone was connected, and there, in the middle of a grass plot, we heard both human speech, and a message rapped out in Morse code, from an instrument in the Palace. There is, of course, nothing novel in wireless telephony.

It is intended shortly to give another demonstration, when wireless telephonic communication over a distance of 30 miles will be attempted, and syntonous wireless telephony demonstrated.

Pacific Cable.—In the House of Commons last week, Mr. Hayes Fisher said that the loss on the working of the Pacific cable for the coming financial year is estimated, on the basis of the present receipts, and after allowing for interest and sinking fund and depreciation, at about £95,000. Five-eighteenths of the actual loss will fall on the taxpayers of the United Kingdom. The right hon. gentleman added that the route *vid* Fanning Island which the cable follows was adopted on the recommendation of the Pacific Cable Committee, over which Lord Selborne presided, and was selected in order that the cable might touch on no territory which was not British. It is estimated that if the cable had been taken *vid* Honolulu the cost of its construction would have been about the same as that which has been incurred.

Wireless Telegraphy.—The *St. James's Gazette* of the 4th inst. contained the following interesting "Special Information" respecting the negotiations which have been proceeding between the Post Office and the Marconi Co.:—

"The Postmaster-General, we believe, has replied to the Marconi Co. regarding the request for facilities to enable messages to be handed in at any post office in the United Kingdom for transmission across the Atlantic. Mr. A. Chamberlain says that he cannot lay down conditions which will ensure that the facilities granted shall be of a permanent character. The company may have the facilities they ask for, he states, provided that it is clearly understood that the Government may call upon the company to agree to conditions which may from time to time be formulated in the Imperial interests. The company, we understand, regard the reply as anything but satisfactory on account of what they consider to be the very insecure position in which they would be placed by such an agreement. They are prepared, they say, to comply with any reasonable conditions which the Postmaster-General may lay down. In the interview which Mr. Marconi, Sir Charles Euan-Smith, and Mr. Hall, the manager, had with Mr. A. Chamberlain, the company's representatives expressed themselves ready to give a demonstration, although in view of what had already been done—the *Times* service and the hundreds of other messages that have been sent—they thought that it was rather superfluous."

"Another point was raised by the Post Office, namely, how far the Department could depend upon messages which they accepted reaching their destination on the other side. It was pointed out that as far as Canada was concerned, the company had come to an arrangement with the Canadian Government regarding the use of the land lines. It had been arranged that a private wire should be erected between the Marconi station at Cape Breton and the nearest Government telegraph office, some 20 miles distant, and that the Marconi messages would be accepted by all private companies in virtue of the agreement the Canadian Government had with these companies. Similar arrangements would be in force in the United States. The postal telegraph lines, which are owned by the Commercial Cable Co., had come, it was stated, to an agreement with the Marconi Co., and the latter's messages in consequence would have the benefit of the interchangeable system between all the companies in the United States. In the company's opinion, therefore, there was ample security for the due delivery of the messages. In any event the Post Office would not be called upon to bear any financial responsibility. The company were prepared to undertake that if any message was not delivered they would refund the whole of the money paid by the sender, and also the Post Office charge.

"The company feel themselves aggrieved at the turn events have taken. Sir Charles Euan-Smith, it may be remembered, stated at the annual meeting of the company the other day that they had no reason to believe that the conditions which the Postmaster-General would lay down could not be accepted by the company. They relied for this belief partly on the friendly attitude which successive Postmasters-General, including Mr. A. Chamberlain, had taken up, but more particularly on a promise which Lord Londonderry made when he filled the position. His Lordship told the Marconi Co. that the facilities they asked for would be granted if the Admiralty withdrew its opposition. That condition the company claim has been fulfilled, for the Admiralty have entered into a comprehensive agreement with them. The Postmaster-General disclaims any responsibility for promises made by his predecessor. A board meeting of the company will be held at an early date to consider the situation. At present the negotiations are considered to have reached a deadlock. Until the facilities requested by the company are granted, the public and Press generally cannot avail themselves of the system.

"We understand that the contract between the Admiralty and the Marconi Co. is of an omnibus character. The Admiralty will pay down a lump sum, and make an annual payment which will not vary in amount however many installations they may make use of. The only additional outlay on the part of the Admiralty will be the price of each apparatus."

In its issue of 7th inst. the *St. James's Gazette* adds:—

"The Post Office now says there will be no attempt to handicap the Marconi system as against the cable companies. The restrictions imposed on the Marconi system will be the same in spirit as those imposed on the other companies, and restrictions are necessary if the Government is to maintain its monopoly of inland telegrams and to look after national interests generally. The Marconi people, as soon as they are ready to send messages in the ordinary way of commerce (an official of the Government Telegraph Service says), will certainly not find any extraordinary official difficulties in their path."

CONTRACTS OPEN AND CLOSED.

OPEN.

Aston Manor.—April 17th. Free wiring and motors for the U.D.C. See "Official Notices" April 3rd.

Austria. — May 1st. The Laa-am-Thaya (Lower Austria) Communal Council wants offers for the establishment of a central power station for the production of energy and lighting by gas or electricity.

Bath.—April 20th. One 500-KW. steam dynamo, 200-KW. balancer, water-tube boiler, &c. See "Official Notices" April 3rd.

Bath.—April 27th. Cables for Corporation electricity supply extensions. See "Official Notices" to-day.

Batley.—April 18th. Eight electrical cars. See "Official Notices" March 27th.

Bedford.—April 20th. One water-tube boiler for the electricity works. See "Official Notices" April 3rd.

Belfast.—April 10th. Water-tube boiler with superheater and mechanical stoker, and superheater for Lancashire boiler. See "Official Notices" March 20th.

Belgium.—April 11th. Tenders for the Municipal Authorities of Liège, for the installation of a complete electric lighting plant at the Theatre Royal, Liège. Tenders to L'Annexe de l'Hotel de Ville, Liège, whence full particulars may be obtained for 30 francs.

Bridlington. — April 21st. Two 100-KW. steam dynamos, booster, crane, Lancashire boilers, battery, switchboard, mains, piping, street lamps, &c., for the electric lighting scheme. See "Official Notices" March 27th.

Cairo (Egypt).—May 12th. The Egyptian Government is inviting tenders for an installation for the transmission of power for public and private purposes at Ghiza and Jhezira. See this column for April 3rd.

Darlington.—April 18th. Overhead equipment, switchboard extension, booster and battery, for the Corporation light railways. See "Official Notices" March 27th.

Eccles.—April 18th. Lancashire boiler, engine, alternator and other plant; also free wiring. See two "Official Notices" March 27th.

Edinburgh. — April 13th. Carbons, also pavement and road-box frames and covers, &c. See "Official Notices" March 20th.

Faversham.—April 27th. Two 80-B.H.P. oil engines, battery, switchboard, and mains. See "Official Notices" April 3rd.

Finchley.—April 11th. Piping, switchboard, boosters, &c. See "Official Notices" March 20th.

France.—April 21st. Tenders are being invited until the 21st inst. by the French Post and Telegraph Authorities in Paris, for the supply of eight lots of telegraphic apparatus. Tenders are to be sent to Le Sous-Secretariat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, whence particulars may be obtained.

Glasgow.—May 4th. Cables, meters, carbons, &c., for the electrical department. See "Official Notices" to-day.

Govan.—April 27th. Battery, boosters, switchboards. See "Official Notices" to-day.

Great Yarmouth.—April 22nd. High-tension cables for electric lighting. See "Official Notices" to-day.

Hackney.—April 30th. Ferranti switchboard extensions, &c, piping and valves, and meters for the Council. See "Official Notices" April 3rd.

Huddersfield.—April 16th. Uniform clothing for inspectors, motormen and conductors for the Tramways Committee. See "Official Notices" March 27th.

Ipswich.—April 27th. Piping, pumps. &c., for the electricity scheme. See "Official Notices" March 27th.

Islington.—April 21st. Mains (solid) extensions and supply meters. See "Official Notices" April 3rd.

Kettering.—May 1st. Boilers, engines, dynamos, battery, switchboard, lamps, mains, &c., for electric lighting installation. See "Official Notices" April 3rd.

Maidenhead.—April 21st. One 200-KW. steam dynamo, and one water-tube boiler. See "Official Notices" March 27th.

Manchester.—April 16th. Direct current motors for the Electricity Committee. See "Official Notices" March 27th.

Newport (Mon.).—April 27th. Two multipolar motors. See "Official Notices" to-day.

Rangoon.—July 1st. The Municipal Committee wants tenders for carrying out its electric lighting license, and particulars, forms, &c., can be obtained from the officiating secretary (W. Shircore), Rangoon municipality, at Rs. 75 per set.

Roumania.—April 28th. The Municipal Authorities of Constanza are inviting tenders until the 28th inst. for the lighting of the town either by gas or electricity.

Swindon.—April 21st. Cables for 12 months. See "Official Notices" to-day.

Trafford Park.—April 10th. The Trafford Power and Light Supply (1902), Ltd., wants tenders for a traction switchboard and accessories. See "Official Notices" March 27th.

Wakefield.—April 18th. Boiler, condenser, and other details. See "Official Notices" April 3rd.

CLOSED.

Bradford.—The Corporation has accepted the tender of the British Westinghouse Electric and Manufacturing Co., Ltd. (Manchester) for two generators required at the Valley Road generating station, for the sum of £6,944, with spare parts.

Burnley.—The Tramway Committee has accepted the tender of Messrs. R. W. Blackwell & Co., Ltd., for the equipment of the branch tramways at £3,560.

Bury (Lancs.).—The T.C. has accepted the tender of Messrs. Macartney, McElroy & Co., Ltd, for the overhead equipment of the Fairfield section of the tramways.

France.—The French Post and Telegraph Authorities in Paris have just placed contracts as follows:—Les Trefileries du Havre, 10 tons of galvanised iron wire, 1 mm. dia., at 4,145 fr. per ton; and La Société Metallurgique de Jorcy, 100 tons ditto, 3 mm. dia., at 2,700 fr., and 90 tons ditto, 4 mm. dia., at 2,550 fr.

Ilford.—The contract for 12 months' supply of cables, joint boxes, &c., required by the U.D.C. has been given to W. T. Henley's Telegraph Works Co, Ltd.

Stepney.—The B.C. has accepted the tender of Messrs. Babcock & Wilcox for an additional boiler at £1,650.

London County Council.—The Highways Committee reported at Tuesday's meeting of the L.C.C. that they had considered the tenders received for the supply of 100 bogie-truck tramcars required for use on the New Cross to Greenwich section of the tramways. Ten firms submitted 25 tenders in all for the supply of the cars:—

BOGIE-TRUCK CARS.

No	Name of firm tendering.	Price for 100 cars.	Proposed sub-contractors for various parts of the cars.				Period of delivery after date of order.	
			Truck.	Body.	Plough.	Electrical equipment and motors.	1st 50 cars.	2nd 50 cars.
		£ s.					Weeks.	Weeks.
1	British Westinghouse Company (accepted)	65,968 0	European McGuire	Brush Co., or British Electric Car Co.	Reyrolle ..	None	22	28
2	Do. do. ..	66,696 0	J. G. Brill Co. ..	Do. do. ..	Do. ..	None	22	28
3	Do. do. ..	67,568 0	European McGuire	G. F. Milnes	Do. ..	None	22	28
4	Do. do. ..	68,468 0	J. G. Brill Co. ..	Do.	Do. ..	None	22	28
	Dick, Kerr & Co.	69,364 0	None	Electric Railway & Tramway Carriage Co.	J. G. White	None	24	24
6	Do.	69,864 0	J. G. Brill Co. ..	Do. do. do.	Do. ..	None	24	24
7	British Thomson-Houston Co.	69,896 0	Brush Co.	Brush Co., G. F. Milnes, or British Electric Car Co.	Do. ..	None	20	25
8	Brush Co.	70,160 0	None	None	J. G. White	None	18	26
9	British Thomson-Houston Co.	70,496 0	European McGuire	Brush Co., G. F. Milnes, or British Electric Car Co.	Do.	None	20	25
10	Witting Bros.	71,046 0	Do. do.	Brush Co.	Do. ..	Electricité et Hydraulique	26	26
11	British Thomson-Houston Co	71,196 0	J. G. Brill Co. ..	Brush Co., G. F. Milnes, or British Electric Car Co.	Do.	None	20	25
12	Siemens & Halske	71,926 8	Do. ..	G. F. Milnes	—	None	20	20
13	Witting Bros.	72,046 0	Do. ..	Brush Co.	J. G. White	Electricité et Hydraulique	26	26
14	British Schuckert Co. ..	72,278 0	Brush Co.	Do.	Do.	None	21	27
15	Hungarian Railway Carriage and Machine Works, Ltd.	72,374 14	None	None	—	Siemens & Halske ..	48	65
16	Brush Co.	72,380 0	J. G. Brill Co. ..	None	J. G. White	None	18	26
17	Electrical Co.	72,458 0	Brush Co.	Brush Co.	Do.	Allg. Elek. Gesell. ..	26	33
18	Siemens & Halske	72,526 8	G. F. Milnes	G. F. Milnes	—	None	10	20
19	Hurst, Nelson & Co. ..	72,774 10	None	None	J. G. White	Electricité et Hydraulique	35	47
20	Hungarian Railway Carriage and Machine Works, Ltd.	72,774 14	J. G. Brill Co. ..	None	—	Siemens & Halske ..	48	65
21	British Schuckert Co.	72,790 0	European McGuire	Brush Co.	J. G. White	None	21	27
22	Electrical Co.	74,558 0	G. F. Milnes ..	G. F. Milnes	Do.	Allg. Elek. Gesell. ..	26	33
23	Do.	73,804 0	J. G. Brill Co. ..	Brush Co.	Do.	Do. do.	26	33
24	Do.	73,904 0	Do. ..	G. F. Milnes	Do.	Do. do.	26	33
25	Hurst, Nelson & Co.	75,974 0	Do. ..	None	Do.	Electricité et Hydraulique	35	47

An incomplete tender was also received.

The Committee after having had before them reports thereon by the officers, are of opinion that the lowest tender, that of the British Westinghouse Electric & Manufacturing Co, amounting to £65,968. should be accepted. This tender provides for the trucks to be supplied by the European McGuire Manufacturing Co., while the bodies and the ploughs will be made by the Brush Electrical Engineering Co. and Messrs. A. Reyrolle & Co. respectively. The times for delivery are considered satisfactory. The wattmeters will be manufactured by the B.T.H. Co.

The tenders for 100 single-truck cars for use on the New Cross to Greenwich, &c., tramways were from 10 firms, the tenders numbering 32 as follows:—

SINGLE-TRUCK CARS.

No.	Name of firm tendering.	Price for 100 cars.	Proposed sub-contractors for various parts of the cars.				Period of delivery after date of order.	
			Truck.	Body.	Plough.	Electrical equipment and motors.	1st 50 cars.	2nd 50 cars.
		£ s.					Weeks.	Weeks.
1	British Westinghouse Co. ..	52,912 0	European McGuire	Brush Co.	Reyrolle	None	22	28
2	Do. do. (accepted)	**53,012 0**	J. G. Brill Co. ..	Do.	Do.	None	22	28
3	Do. do. ..	53,912 0	European McGuire	British Electric Car Co. ..	Do.	None	22	28
4	Do. do. ..	54,012 0	J. G. Brill Co. ..	Do. do.	Do.	None	22	28
5	Brush Co.	55,370 0	None	.. ..	J. G. White	None	18	26
6	British Westinghouse Co. ..	55,712 0	European McGuire	G. F. Milnes	Reyrolle	None	22	28
7	Do. do. ..	55,812 0	J. G. Brill Co. ..	Do.	Do.	None	22	28
8	Brush Co.	56,470 0	Do.	None	J. G. White	None	18	26
9	Dick, Kerr & Co.	56,504 0	None	Electric Railway & Tramway Carriage Co.	Do.	None	24	24
10	British Thomson-Houston Co.	56,766 0	Brush Co.	Brush Co.	Do.	None	20	25
11	Dick, Kerr & Co.	56,904 0	J. G. Brill Co. ..	Electric Railway & Tramway Carriage Co.	Do.	None	24	24
12	Witting Bros.	56,924 0	European McGuire	Brush Co.	Do.	Electricité et Hydraulique	26	36
13	British Thomson-Houston Co.	56,966 0	Do. do.	Do.	Do.	None	20	25
14	Do. do. do.	57,116 0	J. G. Brill Co. ..	Do.	Do.	None	20	25
15	Witting Bros.	57,224 0	Do.	Do.	Do.	Electricité et Hydraulique	26	36
16	British Schuckert Co.	57,644 0	Brush Co.	Do.	Do.	None	21	27
17	British Thomson-Houston Co.	57,716 0	Do.	British Electric Car Co. ..	Do.	None	20	25
18	British Schuckert Co.	57,844 6	European McGuire	Brush Co.	Do.	None	21	27
19	British Thomson-Houston Co.	57,916 0	Do. do.	British Electric Car Co. ..	Do.	None	20	25
20	Siemens & Halske	58,025 4	G. F. Milnes or J. G. Brill Co.	G. F. Milnes	—	None	20	20
21	British Thomson-Houston Co.	58,066 0	Do.	British Electric Car Co. ..	J. G. White	None	20	25
22	Do. do. do.	58, 66 0	Brush Co.	G. F. Milnes	Do.	None	20	25
23	Do. do. do.	58,466 0	European McGuire	Do.	Do.	None	20	25
24	Hungarian Railway Carriage and Machine Works, Ltd.	58,495 14	None	None	—	Siemens & Halske ..	48	65
25	British Thomson-Houston Co.	58,616 0	J. G. Brill Co. ..	G. F. Milnes	J. G. White	None	20	25
26	Electrical Co.	59,142 0	Do.	Brush Co.	Do.	Allg. Elek. Gesell. ..	26	32
27	Do.	59,272 0	Brush Co.	Do.	Do.	Do. do. ..	26	32
28	Hungarian Railway Carriage and Machine Works, Ltd.	59,495 14	J. G. Brill Co.	None	—	Siemens & Halske	48	65
29	Electrical Co.	60,314 0	G. F. Milnes ..	G. F. Milnes	J. G. White	Allg. Elek. Gesell. ..	26	32
30	Do.	60,592 0	J. G. Brill Co. ..	Do.	Do.	Do. do. ..	26	32
31	Hurst, Nelson & Co.	61,715 0	None	None	Do.	Electricité et Hydraulique	35	47
32	Do.	62,515 0	J. G. Brill Co. ..	None	Do.	Do. do. ..	35	47

An incomplete tender was also received.

The Committee referred the tenders to the tramways manager for report, and he recommended that the second, that of the British Westinghouse Electric and Manufacturing Co., amounting to £53,012, should be accepted. This tender provides for the cars to be fitted with Brill trucks, while the bodies and ploughs will be furnished by the same sub-contractors as in the case of the bogie truck cars. The difference between this tender and the lowest was only £100, and the Committee thought that, to ensure prompt delivery, it would be advantageous for the manufacture of the trucks, in the case of the two sets of cars, to be placed with different firms. The Committee concurs with the manager in thinking that the second tender set out above should be accepted.

The tenders received for the supply of the high-tension and exciter switchboards required for the temporary electricity generating station to be established by the Council at the Deptford station of the London Electric Supply Corporation were as follows:—

Messrs. Cox-Walkers, Darlington	£1,179 18 0
The British Westinghouse Electric and Manufacturing Co., Ltd., London (*accepted*)	1,257 7 9
The Electrical Co., Ltd. (Allgemeine Co., Berlin), London	1,425 15 0
Messrs. Elliott Bros., London	1,609 15 6
Messrs. Cowans, Ltd., Manchester	1,661 8 0
The Electric Construction Co., Ltd., Wolverhampton ..	1,764 9 5
Messrs. Siemens Bros. & Co., Ltd., London	1,881 3 9
The British Thomson-Houston Co., Ltd., Rugby ..	1,958 14 8
" " (alternative)	2, 73 14 8
The International Electrical Engineering Co., London	2,232 0 0
Messrs. Ferranti, Ltd., Hollinwood, five tenders varying from	2,069 10 0 to 2 929 10 0
Messrs. Richardsons, Westgarth & Co., Ltd. (Brown, Boveri & Co.)	2,538 4 0

The tenders were referred by us to Dr. Kennedy, under whose supervision the manufacture and erection of the switchboards will be carried out; and, after carefully considering the tenders and making the fullest inquiries with regard thereto, he has advised that that of the British Westinghouse Electric and Manufacturing Co., Ltd., amounting to £1,257 7s. 9d., should be accepted. The lowest tender is that of Messrs. Cox-Walkers, but their proposed design for the switchboards would have to be entirely altered before it could be considered satisfactory for the Council's purposes. Having carefully considered all the circumstances, we are of opinion that the tender of the British Westinghouse Co., which is satisfactory in all respects, should be accepted. The company proposes, should their tender be accepted, to sub-let to Messrs. W. T. Glover & Co. the manufacture of the necessary cables in connection with the work, and we are advised that there is no objection to this course.

When the last County Council order was settled it was thought that the price of cars had reached bedrock, but apparently that was not so. The price then paid by the Council for its first 100 bogie cars was £71,754, giving an average of £717 per car. The Westinghouse contract now decided upon is for a very similar car, the price of 100 being £65,968, or roughly, £50 per car less. For the single truck car the previous price paid per 100 was £58,800, and the price at which the Council are now securing the same car is £53,012, being a difference again of about £50 per car.

Portsmouth.—The Corporation Tramways Committee has accepted the tender of Mr. Coltherup for the construction of new workshops and offices to the designs of Mr. E. Rotter, consulting engineer, under whose supervision the work will be carried out. The amount of the contract is £9,150. The new buildings which are to be situated at North End, will, together with the large car shed already erected there, complete the depôt.

Salford.—The T.C. on April 1st accepted the following tenders for supplies to the electricity works:—Messrs. Charles Macintosh & Co., Ltd., for rubber-covered high-tension cable; Messrs. Johnson & Phillips, for low-tension cable; Messrs. W. T. Glover & Co., Ltd., for lead-covered cable; Anchor Cable Co. for leadless cable; British Westinghouse Co. for alternating current meters; British Thomson-Houston Co. and Messrs. Chamberlain and Hookham, Ltd., for slot meters; Messrs. Ferranti, Ltd., and Messrs. Chamberlain & Hookham for continuous current meters; Messrs. W. H. Bailey & Co., Ltd., Salford, for metal-hinged boxes, &c.

FORTHCOMING EVENT.

Monday, April 20th.—At 5 p.m. Junior Institution of Engineers. Visit to the Brook Green Works of the Incandescent Electric Light Co.

The Dangers of Calcium Carbide.—The *Northern Whig*, of Belfast, which we believe is a responsible and fairly level-headed paper, has recently seen fit to publish an amazing paragraph respecting what it is pleased to imagine the explosive properties of calcium carbide. Describing the unloading of what is said to be the first vessel entering Belfast Harbour with carbide on board, the reporter writes of the extraordinary precautions which were taken in the execution of the work as not being matter for surprise, because calcium carbide is a "highly explosive chemical." "It is used in the manufacture of acetylene gas, and must, therefore (*sic*), be handled with the greatest possible care." "This most dangerous cargo" "was packed in hermetically sealed tin cases, encased again with wood, and before any steps in the direction of unloading was taken the Inspector of Explosives for the port and the harbour police were communicated with"; the unloading taking place between sunrise and sunset, no vessels being allowed to approach the ship during the process. As this deadly material was packed in the proper way, it is difficult to guess what harm the writer imagined could happen during the unshipment, unless some malicious person opened a case and punctured one of the drums. The journal talks of dry carbide as if it were hot acid nitro-glycerine or some "unpermitted" explosive, instead of being absolutely inexplosive and incapable of catching fire. The precautions taken seem only to have been reasonable in view of the ignorance which still prevails about carbide; had they been omitted, journalists would have written about foolhardiness, but as they were taken, they are regarded with panic. Some time ago we read of carbide or acetylene (or both) as "this terrible factor of modern life"; is this sort of thing really ignorance or —— ?

THE INSTITUTION OF ELECTRICAL ENGINEERS IN ITALY.

The following is a list of the members who are taking part in the pilgrimage to the tomb of Volta and the inspection of the electric railways, works, &c., in Northern Italy:—

Adamson, D.; Addenbrooke, G. L.; Alabaster, H.; Allen, A. H.; Allen, R. S.; Andrews, H. G.; Andrews, L.; Aspinall, F. B.; Atchinson, A. F. T.; Baker, C. A.; Ball, R. S.; Biggs, C. H. W.; Boot, H.; Borns, H.; Boschan, A. von (Vienna); Brodie, W. A. (San Remo); Brooke, R. E.; Callis, F. T.; Connolly, Jas.; Connolly, J. T.; Cooper, A. T.; Cooper, W. R.; Crompton, Col. R. E. (Past President); Dawson, P.; Dick, J. R.; Dixon, W.; Dobson, S.; Donner, W. H.; Eck, J.; Epstein, Prof. J. (Frankfort); Erskine, R.; Esson, W. B.; Fawcus, A.; Fawcus, D.; Fawcus, W. P. J.; Feilden, T. J.; Ferranti, S. Z. de (Vice-President); Firth, H. W.; Foyster, A.; Gavey, J. (Vice-President); Geipel, W.; Gerard, Prof. E. (Liege); Gray, R. Kaye (President); Greene, F. A.; Hall, C. J.; Hammond, R. (Hon. Treasurer); Hardy, W. E.; Harling, W.; Hewett, J. R.; Hill, G.; Holden, Col. H. C. L.; Howitt, F. J.; Jackson, F. H.; Jackson, H.; Jacomb-Hood, J. W.; Jones, C. H. McCarthy (Athens); Lacey, E. M.; Lacey, F. W.; Lowcock, G. W.; Luon, J. R. P.; Maclean, Prof. M.; McMillan, W. G. (Secretary); Madden, W. M.; Martin, E. M.; Matthews, R. B.; Mavor, H. A. (Chairman Glasgow Local Section); Metzger, G. F.; Miller, H. W.; Mordey, W. M.; Morris, Dr. D. K.; Morris, J. T.; Morrison, G. J.; Munro, H. D.; Neele, G. M.; Nisbett, G. H.; Paze, D.; Peebles, W. C.; Pescetto, Col. F. (Genoa); Portheim, R. S.; Raworth, J. S.; Rich, T. (Karlsruhe); Robinson, L. L.; Sandberg, O. F. A.; Sankey, P. W.; Sawtelle, G. M.; Scott, E. K.; Scott, W. B.; Shawcross, R. E.; Shiras, O.; Sillar, A. M.; Small, J. C.; Stansfield, H.; Stevens, T.; Stewart, C.; Stirling, C.; Swinton, A. A. C.; Tervet, R.; Thomas, B.; Thompson, Prof. S. P. (Past President); Tonge, J. H.; Tree, R. (Clerk); Turnbull, C.; Venables, A. J.; Walrond, C. T.; Walton, A. H.; Watkinson, Prof. W. H.; Weddell, A. H.; Whitmee, H. B. W.; Wilson, D.; Windham, J. A. (Gibraltar); Wolff, S. M. J.; Wood, A. P.; Woodhouse, C. H. C. (Bordighera); Woolan, E. B.; Woolliscroft, J. H.; Wyld, W.; Yale, T. P. O.

A large number departed on the 1st inst., with a view to breaking the journey at Lucerne. On the following day the remainder of the party got under weigh, leaving England enshrouded in driving rain and shivering with cold—truly appropriate weather, admirably calculated to prepare the travellers for a due appreciation of sunny Italy! The bad weather continued through the day and night, but ceased before Lucerne was reached; here a halt was made, permitting the late arrivals to visit the famous Lion, and the early ones to join the party in the train.

From this point began the really interesting portion of the journey. The region to be traversed was one that is always of fascinating interest to the ordinary traveller; but how much more to engineers, who can appreciate the splendid courage and determination which brought to a triumphant completion that marvel of engineering genius—the St. Gothard! Needless to say, the laborious ascent was observed, with the keenest attention, and the spiral tunnels especially aroused enthusiasm.

On the northern side, as the train plunged into the tunnel, the mists hung low upon the snow-streaked mountain tops, and the air was bitterly cold. Fifteen minutes passed in semi-darkness, accompanied by clang and roar, in an atmosphere which roused faint memories of the London Underground, but far less noisome. Then the train dashed forth into a new climate—the air was clear and warm, the sun brightly shining; a universal feeling of relief was plainly evident in the bearing of the travellers as the sunshine thawed their chilly limbs and cheered their hearts. More spiral tunnels followed, with marvellous examples of under-pinning and retaining walls under dangerous beetling crags and sliding shale. Then the pines and the snow were gradually left behind, and signs of agricultural industry were met with—vineyards on almost inaccessible ledges, patches of grass land and ploughed fields, as the line descended to the valley. Lugano, where Mr. C. E. L. Brown built the first three-phase tramway, was passed through, and the frontier of Italy was quickly reached, followed by the arrival at Chiasso. Here a long wait took place, on account of the requirements of the Custom House. Then a few minutes in the train reached Como.

The Institution received a hearty welcome in Switzerland, France and Germany; but nowhere was there a warmer welcome than at Como! The civic band was drawn up on the platform, and crashed out the British National Anthem again and again, as the train drew up at 7 p.m. The mayor, Cavaliere Sinati, accompanied by Count Reina, Engineer Perti, Prof. Bonardi and other gentlemen, received the President, Mr. R. K. Gray, introduced by Doctor Silvanus Thompson, and the leading members of the party at the station. The visitors then drove in brakes to the various hotels to which they were allotted, saluting *en route* the statue of the great Alessandro Volta, which was illuminated with a searchlight. All Como seemed to be in the streets to welcome the British Engineers, who came to do honour to the illustrious Italian. After a much-needed meal, the visitors retired to prepare for the labours of the morrow.

On Saturday, the 4th inst., in glorious sunshine, the party embarked on a steamer at 8.30 a.m., and steamed down Lake Como between magnificent mountain walls to Varenna. Here they landed, and entrained for Sondrio, on the Valtellina Railway. This, as our readers are aware, is operated entirely by electricity, generated and transmitted to sub-stations at 20,000 volts, and delivered to the three-phase motors on the trains at 3,000 volts. *En route* a halt was made to inspect a goods locomotive of 1,000 H.P. (the passenger trains are hauled by motor-cars of 600 H.P.) and a sub-station. The journey to Sondrio, along the edge of the lake, and for considerable lengths in tunnel, occupied in all about two hours. Frequently the speed exceeded 40 miles per hour. There was absolutely no hitch; but for the absence of smell, smoke and filth, and of anything like a locomotive, there was little to show that the train was not hauled by steam. Only the two overhead wires, supported partly by span-wires and partly by bracket arms, with the contact rollers on the leading car, gave a clue to the motive agency. The line runs through an agricultural district, closely cultivated, with vineyards, peach and other fruit trees, and mulberry trees in abundance. It should be mentioned that the staple trade of this part of Italy is silk manufacture.

Arrived at Sondrio, the visitors were entertained to luncheon by the Adriatic Railway Co., the owners of the line, who also kindly provided the special train, and whose chief engineer accompanied the party. Herr Blâthy, of the Ganz Co., Signor Bertini, Signor Semenza, and other distinguished engineers were also present.

Senator Colombo, chairman of the Italian Edison Co., who was mainly instrumental in carrying through the preliminary arrangements for the visit, was unfortunately unable to be present, but telegraphed his regrets. A number of engineers from Milan also took part in the excursion.

Keen interest was shown in the construction and working of the line, which is over 60 miles in length. The system is most simple in both respects. The poles are all of wood; where span wires are used, a wooden strut is fixed between the tops of the poles, below which are the span wires—one for each trolley wire. The bracket arms are of steel.

The three 20,000-volt mains are generally carried on an extension of the poles, on one side or the other of the line, on specially-designed but neat and small porcelain insulators; they are, however, not carried through the tunnels.

At passing places (the line being generally single) the outer wires are continued unbroken, while the inner wires are interrupted by section insulators; the motors therefore run as single-phase motors at these points. There are four motors on each motor-car, two of which are in cascade with the other two at starting, but are cut out altogether at full speed. All the switching gear is operated by compressed air.

No electrical engineer who has spun along at 40 miles an hour in these comfortable trains can fail to experience a feeling of exultation at this splendid achievement, or to realise that electric traction on railways is no chimera, nor a matter of future ages, but is a thing of the present, throbbing with life and vigour!

At Sondrio, where the electric line joins the steam railways of the Adriatic Railway Co., the visitors excited much interest, the inhabitants assembling in crowds to view the unaccustomed spectacle. The luncheon was excellent, and the speeches short. Immediately afterwards the party resumed their seats in the train, and returned as far as Morbegno, where they descended from the train and walked about a mile and a half to the power station. This is supplied with water at a head of 100 ft. from the River Adda by a tunnel and two pipes. There are three generating sets, each consisting of a 2,000-KW. 20,000-volt Schuckert three-phase

alternator, working at 15 cycles per second, and coupled to a Francis turbine built by Messrs. Ganz & Co., of Buda-Pesth. There is space in the station for a fourth set, which will be of 3,000-KW. ouputt. Each set carries its own exciter, and is controlled by a powerful hydraulic relay system brought into action by the governor. The generators are of the revolving field type, running at 150 revolutions per minute. The switchboard was also made by Messrs. Schuckert, of Nuremberg, and is a very handsome structure.

Much interest was taken in the lightning arresters on the extra high-pressure lines, consisting of three jets of water from earthed nozzles projected upwards into umbrella-shaped basins connected with the transmission lines. These put a permanent earth on the line, but owing to the high resistance of the jets, which are ½ in. in diameter, and about 10 in. long, only about 3 KW. is lost in this way, while the protection against lightning is perfect. After inspecting the power station, the party returned to the railway and journeyed to Varenna. Here the engineers of the line were bidden farewell, and the visitors embarked on the steamer to return to Como, enjoying *en route* a highly-appreciated cup of tea. Dinner at the various hotels completed the day, save for a walk through the town to view the illuminations which had been prepared in honour of the visitors.

On Sunday the 5th inst., after morning in the Plinius Grand Hotel, the President and most of the members of the party, drove to the tomb of Volta to lay a wreath on the tomb, and to offer a memorial shield, presented by the students of the Institution. An account of the proceedings at the tomb must be deferred to a later issue.

(*To be continued.*)

NOTES.

The American Electro-Chemical Society.—The third general meeting of this Society is to be held in New York City on April 16th, 17th and 18th. The following are mentioned in the programme of matters coming up for consideration:—

"Constant Voltage and Constant Current Separations," by Wilder D. Bancroft, Ph.D.
"Experimental Study of Some Electrode Effects," by H. T. Barnes, Ph.D.
"The Electrolysis of Water," by J. W. Richards, Ph.D., and W. S. Landis.
"Experiments with Metallic Diaphragms," by Wilder D. Bancroft, Ph.D.
"The Protective Action of Zinc Chloride on Metallic Iron," by C. J. Reed.
"Insulating Materials: A Field for Chemists," by M. Von Recklinghausen, Ph.D.
"A Historical Review of the Storage Battery." With illustrations. By H. B. Coho.
"The Use of Pyroxyline in Electric Storage Batteries," by Elmer A. Sperry.
"The Concentration Changes in the Electrolysis of Brine," by W. H. Walker, Ph.D.
"The Influence of Some Impurities in Salt upon the Yield of Soda by the Amalgam Process," by J. W. Walker, Ph.D.
"The Corrosion of Metals by Electrolysis," by A. A. Knudson.
"Modern Electrolytic Copper Refining," by Titus Ulke, M.S.
"Notes on the Composition of Electro-Plating Solutions," by N. S. Keith, Ph.D.
"The Formation of Nitric Acid Under Electric Influences," by C. W. Volney, Ph.D.
"Note on Electrical Endosmose," by Wilder D. Bancroft, Ph.D.
"Ions and Electrons," by Louis A. Parsons, Ph.D.
"Uniformity in Electro-Chemical Equivalents," by Carl Hering.
"Electromotive Force of Alloys," by W. D. Bancroft. Ph.D.
"Electrolytic Production of Metallic Compounds," by C. F. Burgess, E.E., and Carl Hambuechen. Ph.D.
"The Electro-Deposition of Metals upon a Rotating Cathode," by J. G. Zimmerman.

On Friday evening, 17th inst., the Society will be the guests of the American Institute of Electrical Engineers, at which the programme is as follows:—

1. Introduction: President Scott.
2. "Radium and Other Radio-Active Substances, and Certain Phosphorescent and Fluorescent Substances. The Properties and Applications of Selenium. The Treatment of Disease by Ultra-Violet Rays." By Wm. J. Hammer.

"Electrolytic Conduction Without Electrodes," by A. B. Marvin.
"A New Type of Electrolytic Cell," by P. G. Salom.
"Potentials of Zinc in Aqueous Solutions," by H. E. Patten and W. R. Mott.
"Notes on Electrolytic Deposition of Nickel," by Woolsey McA. Johnson.
"What is the Capacity of Molecules for Electric Charge in Electrolysis?" by Alfred H. Cowles.
Exhibit of Aluminium Corrosion, by J. A. Steinmetz.
Exhibit of New Apparatus, by A. Eimer.

America's Shortcomings.—Mr. Geo. N. Barnes, who was one of 23 trades unionists taken to the United States by Mr. Alfred Mosley, has given us his impressions of the things he saw there in the pages of *Cassier's Magazine*. The American patent law he considers good, apparently because it is cheap, an American patent costing £7 only; but we believe it costs just as much or more to uphold a patent there as here, and the value of a patent anywhere seems only to be the owner's ability and long pocket to fight. Mr. Barnes is also full of admiration for the natural resources of America, which he seems to compare in his mind with those of Great Britain, and not with those of the whole of Europe, which would indicate a keener sense of proportion. Coming to social matters and manufacturing, however, what strikes him particularly is the low standard of both. The contraptions of the boodler and company promoter, the slovenly towns, and the monopolies and their works strike him as they strike everyone with a sense of the discomfort of things. American industry appears to be given over to the production of quantity. Quality, finish, durability, all these are not merely not first, they count nowhere, until shoddiness has become extolled as a virtue and the premature scrap heap is made the point of aim. Hence the stunted, narrow views and the degradation of the American worker to narrow positions, where more broadly trained aliens too frequently act as foremen and superintendents. The so-called gang bosses controlling gangs of specialists are denounced as sweaters. Here they are called sweaters, and Americans notice our use of the term, and are freely condemnatory of the sweated labour of Europe, and so on. But the American sweater is a scorpion compared with European whip, and his little finger is thicker than the loins of the European; but he is not a sweater—he is a gang boss—which Mr. Barnes thinks points a distinction with little difference save in favour of the sweater. The American worker is described as a grubber of dyspeptic complexion who has got beyond the British habit of taking his pleasures sadly, for he takes them not at all. Throughout everything want of finish and lack of durability mark the country. Our critic compares Blackwall Tunnel with the dirty, dingy, leaky holes of Chicago, and he does not even give credit for the social equality so loudly boasted, seeing only a certain free-and-easy style between bosses and workmen, but nothing that points to any social equality. He does not even admire the rowdy bloodthirstiness of the American strike, and avers an absence of fellow feeling everywhere. Certain it is that of Americans who come over to Europe there is very little of the live and let live spirit apparent. The American rarely speaks enthusiastically of what he is going to make for his shareholders; it is almost always of how he is going to smash the other fellow into perdition, only he uses a four-letter word as the destination. Generally, Mr. Barnes regards the Americans as neurotic and unhealthy, and liable in the effort to lick creation to get themselves prematurely used up in the process. Altogether Mr. Barnes does not draw a nice picture, but we think it possibly somewhat overdrawn. There is so much of a basis of truth in it all that one cannot pick out any particular holes. But Mr. Barnes was only over on a short visit, and in these flying visits one sees the very worst of America, the hurry, the race for dollars, and all the horrible faults of Europe doubly intensified. There is another side of American life, to enter which the casual visitor hardly finds time or opportunity, and, perhaps, after all, Americans will discover that there is a better end to life than becoming a bloated millionaire. When they find this out, they have the means to hand to render more difficult the gigantic monopolies which make for millionaires. One sometimes thinks that much of the hurry of America may after all be merely illusory, and that there is not much real difference in the end.

Boiler Horse-Power.—We are constantly coming into contact with the term boiler horse-power. Originally the horse-power was a horse-power plus about 50 per cent, to prevent all possible cavilling as to what a steam engine would do. Steam pressures were very low; an engine would run at full power with a hole in the boiler. Thus the safety valve could be removed, and the engine would run. One of our friends has run an engine for half an hour after the fusible plug had melted out and the fires had been drawn. The damper was shut, and the hot brickwork helped to generate steam, until so much air was in time drawn in at the plug-hole that the vacuum was too much impoverished to run the loaded engine. In this case the engine was an old-fashioned beam engine of 30 *nominal* horse-power, and being much underloaded, a breath of steam sufficed to produce a vacuum. The nominal horse-power was simply Watts figure of 33,000 foot-pounds per minute, as determined by him, being 50 per cent. in excess of the rate of work of a London drayhorse. Very quickly the nominal power of an engine became less than the indicated power, for steam pressures rose, and engine speeds increased. The nominal horse-power was supposed to be rated on so many square inches of piston area, and a speed of 220 ft. per minute. As engineers, we all seem to be too anxious to find new units. With a hundred years of experience behind us we try to give new values to the horse-power as a unit. We are all right as regards an engine, for we can rate it at so many brake horse-power with a certain pressure. But when we try to fix the size of a boiler in horse-power, we are measuring land areas with a pint pot. There is no suitability of measure. A boiler horse-power is now often measured as its capacity to evaporate, so many times about 30 lbs. of water. Would it not be better to adhere to the unit of evaporation of 1 lb. of water from and at 212° F. This is a definite unit which is fully recognised. The so-called boiler horse-power is merely so many of the pound units evaporation. The boiler horse-power must be converted into actual horse-power for every class of engine, and merely introduces a confusion. It is simply a new kind of nominal horse-power. The disappearance of this as regards engines has often been hailed with joy. Why resuscitate the confusion? It is easy enough to say a 12,000-unit boiler and takes as few figures or letters as to say a 400-H.P. boiler, while, at the same time, it expresses a definite capacity to evaporate a given weight of water per hour from and at 212° F. Why should any weight of steam produced represent a horse-power? Some engines use less than 10 lbs. of steam, others probably use 100 lbs. per horse-power-hour. There is no uniformity of steam consumption by an engine that enables us to employ the conventional boiler horse-power to any better advantage than the old nominal horse-power.

The Engineering Standards Committee.—The Board of Trade laid the request of this Committee for a grant in aid of the funds before the Lords Commissioners of His Majesty's Treasury, and urged in support thereof that the work being carried out by the Committee was of the greatest importance and one that might well be encouraged by the State. In response, the Treasury have expressed their willingness to include in the Board of Trade Vote for 1903-4 a sum of £3,000 as a contribution to the funds of the Committee for that year only, on the understanding that they are not thereby pledged to continue the grant in later years. After the sum has been voted by Parliament for the purposes of the Committee, the actual expenditure under the vote will have to be authorised by the Board of Trade on the recommendation of a Committee to be specially appointed for the purpose by the Institution of Civil Engineers, and on this Committee there will be one *ex-officio* representative of the Board of Trade. In conveying to the Engineering Standards Committee the decision come to by the Treasury as to the grant to be made, the Board of Trade state that they regard the work undertaken by the Committee, including as it does the preparation of standard specifications for engineering works, and of standard sections of rolled iron and steel, together with the standardisation of parts of locomotives and electrical appliances, as tending to reduce both the cost of production and the time occupied in completion, and as being of the highest value to the country at large.

The Committee placed the Board of Trade's letter before the Council of the Institution of Civil Engineers, with the result that that body is prepared on behalf of the Institution to deal with the question of making recommendations as to the expenditure under the vote in accordance with the Board's terms. The Committee in question will consist of the following:—The President of the Institution of Civil Engineers; the Senior Vice-President; Mr. James Mansergh, F.R.S., Past President; Sir John Wolfe Barry, K.C.B., Past President; Sir William Preece, K.C.B., Past President; Sir Benjamin Baker, K.C.B., Past President; Sir Douglas Fox, Past President; Mr. Archibald Denny, M.Inst.C.E.; with a representative of the Board of Trade. The Standards Committee express their appreciation of the Government's desire to assist the trade of the country by placing at their disposal not only financial support, but also the valuable services of representatives of the various Government departments. The Committee also expresses the hope that when the present vote is exhausted the Government will favourably consider the desirability of further assistance, as they attach very high importance to the necessity of organising a permanent body which shall keep in touch with the scientific and practical development of the trades concerned, and be prepared to revise the standards by addition or deletion, and to modify the methods of testing as necessity may arise.

The I.E.E. Students and the Building Fund.—The Students' Section of the Institution of Electrical Engineers, as a result of its recent effort, has been able to hand over to the Institution Building Fund the sum of £79 10s. 6d., and a number of the students have agreed to make small annual subscriptions to the fund. This is a very creditable showing, and is worthy of praise. It shows clearly that the younger members are ready to express in a practical manner their appreciation of the great benefits which they obtain from the Institution. The movement has been most enthusiastically worked, and the Students' Committee may well be pleased with what has been accomplished.

German Competition in South Africa.—One of the directors of the Allgemeine Elektricitäts Gesellschaft is now on his way to South Africa (says the *Rand Daily Mail*), where he will represent the concern and arrange for contracts which will be executed in England. The firm intends to make an effort to capture as much as possible of the South African trade, and it undoubtedly has some working understanding with the new amalgamation of Siemens, Halske & Schuckert.

Will.—The will of the late Mr. Sidney Howe Short, electrical engineer, of 4, Whitehall Court, S.W., has been proved at £18,821.

London Omnibuses.—The London General Omnibus Co. has received the first of its experimental motor omnibuses. It has come from the Fischer Motor Vehicle Co., of Hoboken, U.S.A., and was ordered in June last year to specifications prepared by the London General Co. The *Westminster Gazette* says that it is fitted with a petrol motor driving a dynamo, and motors are geared to the rear wheels.

Appointments Vacant.—There are a number of vacancies for experienced telephone men in the Cape Colony service; an electrical engineer at £150 is wanted for Mexborough electric lighting and dust destructor station; mains superintendent for Electricity Department at South Shields (£150—£200); traffic superintendent for Oldham tramways (£130); chief assistant electrical engineer for Ashton-under-Lyne (£150). See our advertisement pages to-day.

British Electric Street Tramways, Ltd.—Mr. Justice Buckley sitting for the disposal of companies' business in the High Court of Justice on Tuesday, had before him a petition by A. J. Paine, for the winding-up of the British Electric Street Tramways, Ltd. Mr. Buckmaster, K.C., who appeared for the petitioner, stated that there had been a considerable amount of evidence filed, and it was desired to file further evidence. In the circumstances he asked that the petition should be allowed to stand over till the first day in next term. His Lordship assented.

Radiant Radium.—Wonderful are the properties of radium! A leader writer in "the *Queen*, the lady's newspaper," has made the discovery that a rich man would be able, by putting a block of radium in his fire-place, to warm his rooms in winter without the aid of the cheerful, but dust-diffusing coal. Our readers are aware that radium is continually giving off heat, and is itself invariably warmer than the surrounding substances by 2·7° F., but fancy heating one's room with the temperature at freezing point inside, and the chunk of radium only 2·7° warmer! But, as the writer triumphantly exclaims:—"The mind, once freed from the trammels of hitherto accepted scientific dogma, fairly revels in the prospect opened up by the magic powers of radium." So say all of us!

Personal.—Mr. George Whale has been appointed chief mechanical engineer to the London and North-Western Railway, in place of Mr. F. W. Webb, who has resigned after 32 years' service with the company.

The Telescriptor Syndicate.—In the House of Commons on the 7th inst., Mr. Hayes Fisher made a personal statement resigning his position as Secretary of the Treasury in consequence of the remarks of Mr. Justice Buckley, to which we referred in our last issue. Mr. Fisher's statement was received with general sympathy, in which we join. We cannot but express our regret that his connection with the company should have rendered it necessary for him to sacrifice his position, though we cannot think that the close of his political career (as he expresses it) is necessarily involved. Mr. Hayes Fisher has gained experience, his constituents will recognise that the course which he has pursued is the right course, and even the House of Commons is not unmoved at a feeling recital of the steps taken to remove any doubt of the honour and integrity of one of its members. Mr. Justice Buckley intimated that his Court was "not a Court of Conscience." Mr. Hayes Fisher holds that Mr. Justice Buckley's views of what should be done approach a "counsel of perfection." Even so, it is well for Mr. Fisher to fall in with those views, and we should hope that in the not very distant future he would be re-instated in his political career. He has made amends for his omissions, and he has suffered from his friends. His recompense will doubtless come.

National Electrical Contractors' Association.—A meeting of the Northern Section was held at the Metropole Hotel, Leeds, last Saturday, when members were present from London, Liverpool, Manchester, Blackburn, Ashton-under-Lyne, Leeds, Bradford, Dewsbury, Huddersfield, Stockton, Sunderland, Newcastle and other towns. It was reported that the various sections of the Association are doing good work. Many matters of general interest to the members were discussed, including registration of workmen and the standardisation of wiring rules and specifications, and it was reported that since January last an increase of 20 per cent. in the membership has taken place.

Newport Tramways.—The first section of these electric tramways, also the new power station, were to be officially opened yesterday (Thursday). The luncheon did not take place owing to the death of the Mayor.

THE CENTRAL STATION ENGINEER.

Mr. William Sutcliffe, of Lytham, has been appointed engineer-in-charge at the Paisley Corporation Electricity Works, in place of Mr. A. M. Mulliner, who has obtained the appointment as chief assistant at Leamington. The applications received numbered 41.

Mr. J. E. Edmundson, who has been assistant engineer to the Urban Electric Supply Co. at Glossop station, has been promoted to be resident engineer to Messrs. Edmundson's Electricity Corporation at Scarborough during the construction of the tramways there.

The Portsmouth Electric Lighting Committee has appointed Mr. Hiscock, of South Shields, as superintendent of mains.

Salford T.C. has increased the salary of Mr. E. H. L. Dickson, mains superintendent, from £200 to £240 per annum, on his undertaking to remain in the service of the Corporation for a year from June 1st, 1903.

Mr. W. A. Vignoles, borough electrical engineer at Grimsby, has undertaken to remain in the service of the T.C. for three years.

Mr. T. V. Parsons has resigned the post of assistant electrical engineer at the Salford Corporation Electricity Works.

Mr. S. Ponsford, who has been engaged with the Brechin Electric Light Co. since they commenced operations in Brechin, was on the 3rd inst. presented with a purse of sovereigns as a token of goodwill on his leaving the place.

A Smoking Concert, organised by the staff of the Manchester Corporation Electricity Works, was held on Monday night at the Clarence Hotel, when Mr. Uttley, the senior shift engineer, who is about to sever his connection with the Corporation to take up a responsible appointment under the Rhodesian Government, was presented with a handsome gold watch, suitably engraved, as a token of the esteem in which he is held by the works staff generally. The chair was occupied by Mr. Pearce, the deputy chief engineer; the chairman, Councillor Howarth, and several other members of the committee were also present.

NEW COMPANIES REGISTERED.

Private Wire and Telephone Installation Co., Ltd. (76,888).—This company was registered with a capital of £3,000 in £1 shares, to adopt agreements (*a*) with the Consolidated Telephone Construction and Manufacturing Co., Ltd., and (*b*) with J. J. L. Newland, and to manufacture, construct, maintain, lay down, carry out, instal and deal in articles, apparatus and inventions in connection with the production or use of electricity, especially in respect of electric power for telephones, telegraphs, lighting, fire alarms and other means of communication. The first subscribers (each with one share) are:—J. J. L. Newland, 5, Palmer Street, Westminster, engineer; G. J. R. Stubbs, 22—3, Laurence Pountney Lane, E.C., solicitor; J. Lens, 132, Queen Victoria Street, E.C., ironfounder; H. C. Lassaw, 7, Bermondsey Street, S.E., managing director British Challenge Glaze Co., Ltd.; H. F. Turner, Eaton Lodge, Buckingham Road, Hampton, clerk; F. O. Mills, 23, Woodland Road, Upper Norwood, clerk; and E. R. Nickson, 5, Palmer Street, Westminster, electrical engineer. No initial public issue. The number of directors is not to be less than two nor more than three; the first are J. J. L. Newland, and one other, to be appointed by the subscribers; qualification, £500 shares; remuneration (except managing director) one guinea each per board meeting attended. Registered office, 5, Palmer Street, Westminster, S.W.

Electric Conversion Syndicate, Ltd. (76,877).—This company was registered on March 30th, with a capital of £100 in £1 shares, to carry on the business of company promoters, financiers, concessionnaires, contractors, railway and tramway constructors and owners, manufacturers of rolling stock, stock and share dealers, underwriters, guarantors, &c. The first subscribers (each with one share) are:—A. Silver, 25, Ryder Street, St. James's, S.W., gentleman; H. S. Watkins, jun., 34, The Grove, Hammersmith, engineer; F. B. Fuller, 1, Leadenhall Street, E.C., secretary; J. Service, 10, Constantine Road, Hampstead, N.W., clerk; E. A. Wheatley, 17, Secretan Road, Camberwell, S.E., clerk; J. Cassidy, 75, Turner's Buildings, Westminster, S.W., clerk; and J. McLachlan, 1, Queen Victoria Street, E.C., solicitor. No initial public issue. The number of directors is not to be more than five; the subscribers are to appoint the first.

Procter & Cottrill, Ltd. (76,882).—This company was registered on March 30th, with a capital of £1,000 in £1 shares, to carry on the business of electric light contractors, electricians, suppliers of electricity for light, heat, motive power and other purposes, manufacturers of and dealers in dynamos and electrical apparatus, &c. The first subscribers (each with one share) are:—F. E. Procter, 19, Part Street, Southport, electrical engineer; J. J. Brickhill, 10, Minshull Street, Manchester, cotton merchant, &c.; F. Booth, Sunny Bank, St. Annes-on-the-Sea, medical practitioner; W. Hanchett, 39, Blackfriars Street, Manchester, solicitor; Mrs. M. Booth, Sunny Bank, St. Annes-on-the-Sea; Mrs. G. Brickhill, Hawkesbury, St. Annes-on-the-Sea; and Miss M. M. Cottrill, Ashworth House, Chapel-en-le-Frith. No initial public issue. Registered without articles of association.

Scottish Central Electric Power Co., Ltd. (5,316).—This company was registered in Edinburgh on April 2nd, with a capital of £30,000 in £10 shares, to supply, produce, store and sell electrical energy, power and electricity for public and private lighting, traction, power, heating, chemical, trade, manufacturing and other purposes to which electric power may be applicable, in the counties of Clackmannan, Stirling, Dumbarton and Linlithgow and elsewhere. The first subscribers (each with one share) are:—D. Russell, Inchdairnie, Fife, shipowner; A. Nimmo, Bedlourne House, Blackridge, Linlithgow, coalmaster; H. Hood, Rosewell, Midlothian, colliery owner; J. Gowan, 33, Charlotte Square, Edinburgh, chartered accountant; J. Walker, 25, Frederick Street, Edinburgh, chartered accountant; H. Cadell Grange, Boness, J.P.; and M. Picklowe, Edinburgh, engineer. The number of directors is not to be less than four nor more than nine; to be afterwards appointed. Remuneration as fixed by the company. Registered office, 25, Frederick Street, Edinburgh.

Industrial Storage Battery Syndicate, Ltd. (76,944).—This company was registered on April 3rd, with a capital of £100,000 in £1 shares, to acquire British Patent No. 9,187 of 1901, relating to improvements in electrical accumulators, to adopt an agreement with C. P. Elieson and V. de Bobinsky, to acquire any other patents or inventions connected with the generation, accumulation, distribution, supply or employment of electricity, whether for motive power, light, heat or other purpose, and to carry on the business of electricians, engineers, suppliers of electricity for any purposes, manufacturers of and dealers in all kinds of electrical apparatus and appliances, &c. The first subscribers (each with one share) are:—J. H. Powell, 49, Woburn Place, W.C., clerk; C. E. Howlett, 18, Wiggenhall Road, Watford, secretary; B. H. Anderson, 64, Shepperton Road, N., clerk; E. Taylor, 51, Malvern Road, Leyton-tone, traveller; E. Brown, 16a, Malyon's Road, Ladywell, clerk; F. H. C. Walker, 55, Avondale Road, Peckham, S.E., clerk; and J. B. Galley, 18, Rotherhithe Street, S.E., clerk. No initial public issue. The number of directors is not to be less than three nor more than seven; the first are C. P. Elieson and A. J. Foulding, and others to be appointed by the subscribers; qualification, £100; remuneration £100 each per annum and 10 per cent. on the net profits remaining after payment of 10 per cent. dividend. Registered office, 4, Corbet Court, Gracechurch Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

B. Bridgwater & Co., Ltd. (Constructional and Electrical Engineers, King's Cross) (76,522).—£6,000 debentures, created by resolution of March 10th and dated March 6th, 1903 (*sic*) charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

Northampton Electric Light and Power Co., Ltd. (28,640).—Issue on March 20th of £1,500 debentures, part of a series created June 3rd, 1896, to secure not more than two-thirds of the paid-up capital for the time being (paid up capital now £50,009). Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series: £26,700.

ELECTRIC TRAMWAY ACCOUNTS.

Southampton and Aberdeen Corporation Tramways.

We give this week analyses of the working expenses and a comparison of the undertakings owned and worked by the Corporations of Southampton and Aberdeen. In both cases the tramways were acquired from private companies and transferred in 1898, since when they have been reconstructed for electrical overhead working.

Energy is in both cases purchased from the respective electric lighting departments. The maximum gradients are: Southampton, 1 in 25; Aberdeen, 1 in 21. Mr. H. F. Street is the electrical engineer and tramways manager for Southampton, and Mr. Moonie is the superintendent, with Mr. J. A. Bell as electrical engineer, to the Scottish undertaking.

General particulars.	Southampton.	Aberdeen.
Period covered by returns ...	12 months.	12 months.
Date ending	March 31/1902	March 31/1902.
Length of route	7 miles.	11 miles.
Total length of track	—	19 miles.
Average number of cars in use ...	37*	31*
Car-miles run	854,457†	794,641†
Electrical energy used	723,480 units.	267,853 units.
No. of units per electrical car-mile	·96	·93
Passengers carried per annum ...	7,668,558†	9,099,715†
Capital expenditure to date ...	£150,608	£223,768
Traffic receipts	£43,986	£37,036
Total receipts	£45,169	£37,932
Working expenses	£28,736	£26,577
Gross profit	£16,433	£11,355
Income per car-mile	12·69d.	Horse 10·65d. Elecl. 13·02d.
Working expenses per car-mile ...	8·07d.	Horse 9·07d. Elecl. 6·14d.
Interest, sinking fund and depreciation per car-mile.	1·71d.	Horse 1·58d. Elecl. 6·88d.
		Includes also amounts written off Parliamentary expenses and amount carried to renewal account.
Total expenses per car-mile ...	9·78d.	·98d.
Balance per car-mile	2·91d.	1·84d.
Average fare per passenger ...	1·38d.	
Price of energy per unit	2d.	
Revenue per mile of route ...	£6,453	£3,450
Expenditure per mile of route ...	£4,105	£2,416

* Includes both electric and horse traction.

† Out of the Southampton totals electric cars ran 753,697 miles, and carried 7,949,495 passengers. In the case of Aberdeen electric cars ran 283,067 miles, and carried 4,965,908 passengers.

The two systems have achieved very similar results. Southampton (with a proportion of 88 per cent. of electrical mileage) worked a higher total mileage, carried less passengers, and obtained a figure of 8·07d. per car-mile for working expenses on its combined system, compared with Aberdeen's combined working costs of 7·60d. per car-mile, in which case electrical mileage equals 36 per cent. of the total. In the case of Aberdeen, the individual figures for electric traction compare favourably with other towns using that system, and confirm their traffic experiences, for, with rather over one-third of the total mileage, electric trams carried 54 per cent. of the total number of passengers.

Analysis of Working Expenses.

Southampton.

	Gross.	Per car-mile.
Wages of inspectors, drivers, conductors	£8,071	2·27d.
Electrical energy	6,029	1·70d.
Horse keep and attendance	2,991	·84d.
Rent, rates and taxes	1,984	·55d.
Uniforms, punches, tickets, compensation, oil, coal, water, &c.	889	·2°d.
Lighting depôts and centre poles	688	·19d.
Repairs and maintenance of cars, omnibuses, permanent way, overhead equipment, buildings, &c.	6,509	1·83d.
Management expenses—Including salaries, management of stock, insurance, printing, stationary and advertising	1,574	·442d.
Total working expenses	£28,735	8·07d.

Aberdeen.

	Gross.	Per mile. Horse.	Per mile. Electric.
Traffic expenses, including salaries, wages, clothing, cleaning cars and track, tickets, &c. ..	£8,874	2·90d.	2·23d.
Electrical energy, salaries, &c.	2,743	—	2·28d.
Horse keep and attendance	9,817	4·65d.	—
Repairs and maintenance of permanent way, cars, electrical equipment, buildings, &c.	2,549	·74d.	·85d.
General charges, salaries, office expenses, rates, taxes, insurance, stationary, printing, advertising and sundries	2,594	·78d.	·78d.
Total working expenses	£26,577	9·07d.	6·14d.

In the case of Southampton, the gross profit of the year, £16,433, and the balance from the previous year, £3,021, made a sum of £19,454 for distribution, which provided for financial charges, depreciation, writing off capital account, and a sum of £5,000 credited to the borough fund.

Aberdeen, with a gross profit of £11,355, provided for financial charges, writing off capital account, and depreciation.

Profit Statement.

	Southampton.	Aberdeen.
Interest on loans	£4,272	£6,112
Sinking fund	1,801	1,201
Credit of borough fund	5,000	—
Amount written off capital account	5,865	734
Depreciation and renewals fund	2,516	3,308
Balance brought forward from last year	−3,021	—
Gross profit for the year	£16,433	£11,355

ELECTRICITY SUPPLY ACCOUNTS.

Sunderland Corporation Electricity Department.

The progress made by the electrical department of the borough of Sunderland is of interest to those connected with municipal supply work, in that the department under the direction of Mr. J. F. C. Snell, the electrical and tramways engineer, is laying itself out to provide for a big motive-power load among the numerous shipyards and works on the Wear, a factor which should greatly influence its prosperity in the near future.

During the year ending March, 1901, the department opened a new generating station in Hylton Road, in which some 2,000 H.P. was installed to commence with. There is also provided a direct coal supply line from a neighbouring colliery, and a fully-equipped modern repair shop.

The progress of the undertaking during recent years was as follows:—

Year ending March 31st.	8-C.P. lamps connected.	Max. load in KW.	Total KW. installed.	Units sold.	Load factor.
1898	20,803	360	520	270,352	8·6
1899	25,617	414	696	472,343	13·0
1900	35,024	682	1,120	640,079	10·7
1901	50,092	1,114	1,350	1,218,768	12·4
1902	67,748	1,640	3,280	2,375,557	16·0

GENERAL STATEMENT.

For the year ending March 31st—	1901.	1902.
Total capital	£119,933	£197,282
Number of units sold	1,218,768	2,375,557
Equivalent number 8-C.P. lamps... ...	50,092	66,932
Number of public lamps	—	150
Maximum load in KW.	1,114	1,640
Revenue Account:—		
Gross revenue	£16,526	£26,578
„ expenditure...	9,272	15,212
„ profit...	7,254	11,366
Average price per unit	3·18d.	2·64d.

Out of a total of 2,646,315 units generated, private consumers took 1,002,147 units, public lighting 140,500 units, traction 1,232,910 units, and the remainder comprise works and distribution losses.

The prices charged are:—Private lighting, 5d. per unit for 1½ hours and 2½d. after, with discounts; power, 2½d. per unit, with discounts; public arc lamps, £16 per annum. It will be noted that the works costs show a decrease of nearly ½d. per unit supplied compared with the previous year.

REVENUE STATEMENT.

	Gross.	Per unit.
Sale of energy for private lighting and traction	£25,106	2·64
„ „ public lighting	1,070	
Meter rentals	402	·04
	£26,578	2·68

WORKING EXPENSES.

	1902. Gross.	1902. Per unit.	1901. Per unit.	Increase.
Coal	£7,194	·73d.	·82d.	—·09d.
Oil, waste, water	699	·07d.	·08d.	—·01d.
Wages incurred in generation and distribution and attending public lamps.	2,336	·19d.	·28d.	—·09d.
Maintenance and repairs of plant, machinery, mains, &c.	1,212	·12d.	·15d.	—·03d.
Works and distribution costs	£11,441	1·11d.	1·33d.	—·22d.
Rent, rates and taxes	1,470	·15d.	·14d.	·01d.
Management and general expenses, salary of engineer, clerical staff, printing, stationery, law insurance, &c.	2,301	·27d.	·35d.	—·08d.
Total works cost ...	£15,212	1·53d.	1·82d.	—·29d.

PROFIT STATEMENT.

	1901.	1902.
Interest on loans	£2,974	£4,685
Sinking fund	3,023	4,743
Surplus on year's working ...	1,257	1,938
Gross profit	£7,254	£11,366

With a year's profit balance of £11,366, after providing for financial charges, which are on the ascending scale, owing to the recent large extensions, there remains a surplus of £1,938, as compared with £1,257 in the previous year.

STOCKS AND SHARES.

Tuesday Evening.

With the expectation of cheaper money after the holidays, there has come a better tone over the general markets, and Consols have taken their fair share in improvement. It is thought possible that after Easter we may see that reduction in the Bank rate which has been so long anticipated, and as the supply of floating capital appears to increase every day, there is at least some justification for the suggestion, although no doubt the wish is father to the thought in Capel Court quarters. It is a very moot point whether any general activity will be developed after Easter, but with hope springing eternal in the Stock Exchange breast, all the investment markets show signs of recovery.

Of course the hardening movement has not had so much effect upon Electric Supply securities as it might have done had not this section been enjoying remarkable steadiness during the past three months in a time when gilt-edge securities were anything but in demand. The tone of the Supply department continues good enough to satisfy even the cravings of a jobber, who loves to see his market in popular favour. Edmundsons Preference, although showing no recordable change, are better than they look from the official price, and the same remark applies to Westminsters and Charing Cross shares. The orders which are coming in display a widening tone, purchases being made in greater bulk than is usually the case, and it may be taken for granted that while prices are not likely to move sensationally, their trend will continue to advance with the easing of the money market and the loosening of the public purse strings that is likely to follow therefrom.

Telegraph stocks and shares remain under the lugubrious apprehension of Marconi, and incidentally it may be remarked that the shares of the Marconi concern hover in the neighbourhood of 2⅞. This price is cum the rights which may accrue to holders of the old shares in respect of subscription for the new, although at the moment it is not decided at what price the latter shall be offered. While the nominal price of Marconis is 2⅞—3 the market can scarcely be called a good one, showing that the directors will be well advised not to put too high a price upon their new shares if they want them to be taken up with any avidity.

Naturally enough, it is the Anglo-American stocks which have to suffer most from "Wireless" effects, imaginary though they be. The fall this week, however, is comparatively slight, nor does the Eastern group display much variation. Eastern Extension "China" shares are down ½, thus keeping well under the value which they should bear in relation to Eastern Telegraph stock. The Trust varieties are about the same, and the market on the whole is quiet, if somewhat suspicious. National Telephone stocks exhibit much more spring, and the Deferred continues in request.

The opening of the Hampton Court extension of the London United Tramways Co. had no effect upon the price of the Preference shares or the Debenture stock, which remain at 11⅜ and 107 respectively. London Street Tramways are dealt in about 25s. British Electric Traction continue to be a good market, but the offer to convert more Brush shares into tractions has produced no change in the prices of either.

City and South London Railway Ordinary stock braced up a trifle on the success of the company with regard to its Euston extension. Otherwise, Electric Railway stocks are practically unaltered, although here also the tone is better in sympathy with the hardening of the home railway market generally. It is suggested that the City Co. may require more money in order to construct its line to Euston, but nothing yet has been said officially.

With regard to new-comers, the most interesting is the County of London Brush 4½ per cent. Debenture stock, on which a premium of 1—2 per cent. is already established. At the issue price of 103 the stock looks cheap enough, as compared with several others of a similar class standing on higher levels. A batch of fresh suppliants for money is expected after the holidays.

Indo-European Telegraph Co.—The directors recommend a dividend for the six months ended December 31st, 1902, of 17s. 6d. per share, making with the interim dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of income-tax, in all 10 per cent. for the year.

British Electric Traction Co.—The secretary of the British Electric Traction Co., Ltd., announces that his company has made a further offer of an exchange of shares with the Brush Electrical Engineering Co., Ltd., at the rate of one ordinary share of the British Electric Traction for 12 ordinary shares of the Brush Co.

Stock Exchange Notice.—The Committee has been asked to allow the following to be quoted in the Official List:—British Aluminium Co., Ltd.—10,000 "A" 6 per cent. cumulative preference shares of £10 each, fully paid.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations April 1st.	Closing Quotations April 7th.	Business done week ended April 7th, 1903. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	97 —101	97 —101	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2½ — 3½	2½ — 3½	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	3½%	61s.	60/6	49 — 52	49 — 52	49	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	91 — 93	90 — 92	92	90½
3,105,580	Do. do. do. Deferred	Stock	5s. %	2s.	1/-	8½ — 9	8½ — 9½	8 5/16	8½
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	..	4½ — 4¾	4½ — 4¾	..	..
13,333,300$	Commercial Cable	$100	8 %	8 %	..	160 —170	160 —170	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	89 — 92	89 — 92 xd	90½	89½
16,000	Cuba Telegraph	10	4½%	4 %	..	6½ — 7½	6½ — 7½	..	..
6,000	Do. 10 % Pref.	10	..	..	..	13½ — 14½	13½ — 14½	..	..
12,981	Direct Spanish Telegraph	5	4 %	4 %	4 %	2½ — 3¼	2½ — 3¼ xd	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	7	..
60,710£	Direct United States Cable	20	3½%	3½%	..	9 — 10	9 — 10 xd	..	..
92,800£	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	119 —124	117 —122	121	117
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	84 — 87	84 — 87	85	84⅛
1,594,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	106 —109	106 —109	106½	106
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	..	11¼ — 12⅛	10⅞ — 11⅛	11⅛	10⅞
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	105 —108	105 —108	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	101 —104 %	101 —104 %	..	..
180,227	Globe Telegraph and Trust	10	5½%	5½%	..	8⅞ — 9¼	8⅞ — 9	8⅛	8⅞
180,042	Do. do. 6 % Pref.	10	..	..	..	12 — 13	12 — 13	12⅛	11⅞
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	..	25 — 27	25 — 27	..	..
66,300£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10%	37 — 41	37 — 41	..	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	100 —104	100 —104	..	..
72,680	Montevideo Telephone, Ltd., Ord. Nos. 1 to 72,680	1	2½%	2½%	..	¾ — ⅞	¾ — ⅞	..	..
86,492	Do. do. 5 % Pref., Nos. 1 to 86,492	1	..	..	..	¾ — 1	¾ — 1	..	..
1,983,333	National Telephone, Pref. Stock	100	5 %	5 %	6 %	98 —100	98 —100	99⅜	99
1,966,667	Do. do. Def. Stock	100	..	..	4½%	75 — 77	76 — 78	77⅜	75½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 13	12 — 13	..	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅛ — 5⅜	5⅛ — 5⅜	5 5/16	5⅛
2,000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	97 — 99	97 — 99	98⅜	..
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	102 —104	102 —104	..	..
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	..	¾ — 1	¾ — 1	15/16	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	5 %	..	6¼ — 7⅛	6¼ — 7⅛	..	..
3,808	Submarine Cables Trust	Cert.	..	..	..	105 —115	105 —115	..	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5⅛ — 5⅜	5⅛ — 5⅜	5⅜	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4⅜ — 5⅛	4⅜ — 5⅛	4⅝	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	105 —108	105 —108	..	..
15,609	West African Telegraph, Shares	10	..	..	..	3 — 4	3 — 4	..	..
30,008	West Coast of America, Nos. 1 to 30,000 and 53,001 to 53,008	2½	..	..	..	0 — ¼	0 — ¼	..	..
150,000£	Do. do. 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	96 — 99	96 — 99	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	..	11 — 12	11 — 12 xd	11⅛	11
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	101 —104	101 —104	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	96 — 99	96 — 99	97⅛	..
88,321	West India and Panama Telegraph	10	½%	..	..	½ — ⅝	½ — ⅝	½	..
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6¼ — 6½	6¼ — 6½	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4 — 5	4 — 5	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —102	99 —102	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	3 — 4	3 — 4	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	75 — 80	75 — 80	..	..
100,000	British Electric Traction	10	9 %	9 %	..	13¼ — 14	13¼ — 14	14	13½
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	12 — 12¼	12 — 12¼	12¼	12
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	122 —125 xd	122 —125 xd	124¼	123½
100,000	British Insulated and Helsby Cables	5	15 %	10 %	10 %	7⅞ — 8 xd	8 — 8½ xd	7⅞	7 7/16
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5⅞ — 6¼	5⅞ — 6¼	5 7/16	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	103 —107	103 —107	104	..
50,000	¶Browett, Lindley & Co., Ord.	£1	8 %	Nil	..	12/6 to 13/6	12/6 to 13/6	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	6 %	..	16/6 to 17s.	16/6 to 17s.	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5 %	Nil	Nil	1⅝ — 1¾	1⅝ — 1¾	1⅝	1 11/16
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	3 %	6 %	1¾ — 2 xd	1¾ — 2 xd	1¾	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	89 — 94	89 — 94	..	..
35,000	Callender's Cable Construction shares	5	15 %	20 %	..	13½ — 14½	13 — 14	13⅝	13½
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5⅝ — 6	5⅝ — 6	5⅝	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	108 —112	108 —112 xd	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	..	4 %	4 %	104 —107	104 —107	106	..
494,093	Do. do. 4 % Pref. Stock	Stock	..	4 %	4 %	103 —106	103 —106	104¼	104¼
494,993	Do. do. Def. do.	Stock	..	4 %	4 %	106 —109	106 —109	..	..
1,330,000	City and South London Railway	Stock	1½%	2 %	3½%	75½ — 76½	74 — 76	75	74
85,000	Crompton & Co., Nos. 1 to 85,000	5	8 %	7½%	..	2⅛ — 2⅜	2⅛ — 2⅜	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	102 —106	102 —106	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	2½%	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	2½%	Nil	..	1½ — 2⅛	1½ — 2⅛	..	..
344,022£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	73 — 77	73 — 77	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	75 — 80 xd	75 — 80 xd	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1¾ — 2	1¾ — 2	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2⅝ — 3	2⅝ — 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	99 —102	100 —103	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	10 — 10½	10 — 10½	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	99 —102 xd	99 —102 xd	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	20 %	15 — 16	15 — 16	15½	..
35,000	Do. do. 4½ % Pref.	5	4½%	..	..	5 — 5½	5 — 5½	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	107 —111	107 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18⅜ — 19½	18⅜ — 19½	18⅞	18 5/8
800,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	1½%	1½%	5⅝ — 6	5⅝ — 5⅞	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10½ — 11	10½ — 11	..	..
7,500	Parker (Thomas), Ltd., Ord., Nos. 1 to 7,500	10	..	..	..	14½ — 15½	14½ — 15½	..	..
37,350	Telegraph Construction and Maintenance	12	17½%	20 %	20 %	35 — 39	36 — 39	37½	36
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	101 —104	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3½%	97 —100	97 —100	..	..

† Quotations on Liverpool Stock Exchange.
§ From Bradford Share List.
‡ Unless otherwise stated all shares are fully paid.
¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, nil to 6d.
National Electric Free Wiring, ⅜—½.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 14—15.
Do. do. Pref (£10 pd.), 9½—10½.

Bank rate of discount 4 per cent. (October 2nd, 1902).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations April 1st.	Closing Quotations April 7th.	Business done week ended April 7th, 1903. Highest.	Lowest.
		‡							
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	1	..	..	..	¾ — 1	¾ — 1	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	118 —121 xd	118 —121 xd	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	6 %	8 %	8 %	10¼— 10⅝	10¼— 10⅝	10⅜	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	10 — 10⅛	10 — 10⅛	..	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	10 %	10 %	9 — 9⅛	9 — 9⅛	9⅛	9⅛
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5⅛— 5⅜	5⅛— 5⅜	5⅜	5⅜
40,000	Do. do, "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4¼— 4½	4¼— 4½	4¼	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	104 —106	104 —106	106¾	..
44,436	*Chelsea Electricity Supply, Ord.	5	5½%	4 %	4½%	6 — 6⅛	6 — 6⅛ xd	6⅛	..
150,000‡	Do. do. % Deb. Stock Red.	Stock	..	..	..	109 —112	109 —112	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	0 %	5 %	5 %	9¾— 10⅛	10 — 11	10½	10⅛
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	..	..	13¾— 14½	13¾— 14½	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	122 —127	122 —127	125½	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	103 —106	103 —106	105½	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	4 %	8¾— 9⅛ xd	8 — 9 xd	8⅞	8⅞
20,000	Do. do. 6 % Pref., 40,001—60,000..	10	6 %	..	..	12 — 13 xd	12 — 13 xd	..	..
400,000‡	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red ..	..	..	..	..	109 —112	109 —112	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	6⅞— 7	6⅞— 6⅞	6⅛	6⅛
30,000	Do. do. 6 % Cum. Pref.	5	..	..	..	6 — 6⅛ xd	6 — 6⅛	6⅛	6⅛
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	107 —110	107 —110	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	12 %	10 %	10 %	10¾— 11⅛	10¾— 11⅛	11¼	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	100 —103	100 —103	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	2⅛— 2⅜	2⅛— 2⅜	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5⅝— 6	5⅝— 6	..	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red ..	Stock	..	..	..	100 —103	100 —103	102½	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6 %	6½%	7½%	18½— 19½	17½— 18½	18⅛	17⅝
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	108 —113	109 —114	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	..	..	..	..	98 —101	98 —101	..	..
10,852	Notting Hill Electric Lighting	Stock	..	..	..	98 —101	98 —101	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	10	7 %	6 %	6 %	14 — 15	14 — 15	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	14½%	14½%	14½%	15 — 16	15½— 16½	16	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	5	7 %	7 %	..	8¾— 9¼	8¾— 9¼	..	..
12,000	Smithfield Markets Electric Supply, Ord.	100	..	..	..	98 —101	98 —101	..	..
50,000‡	Do. do. 4% Deb.	5	..	..	2½%	3 — 3⅛	3 — 3⅛	3⅛	3⅛
65,000	South London Electricity Supply, Ord.	100	..	..	..	88 — 93	88 — 93	..	..
30,000	Urban Electric Supply, Ord.	5	..	..	1¾%	3¼— 4 xd	3¼— 4	..	..
30,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4⅛— 5⅛ xd	4⅛— 5⅛ xd	5⅛	..
110,000	Westminster Electric Supply, Ord.	5	..	..	..	4⅛— 5⅛ xd	4⅛— 5⅛ xd	..	..
28,141	Do. do. 5 % Cum. Pref.	5	10½%	10½%	12 %	12 — 13	12 — 13	12⅝	12½
		5	..	..	..	6½— 6⅝	6½— 6⅝	6½	..

*Subject to Founders Shares. ‡Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS. Wednesday, April 7th.

CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a ,, ,, ...	per ton	£30	..
a Bleaching powder	per ton	£4 10	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£23 15	..
a Lead, Nitrate	per ton	£24	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks ..	per lb.	3d.	..
a ,, Caustic (75/80%).. ..	per ton	£24	..
a ,, Bisulphate	per ton	£35	..
a Shellac	per cwt.	119/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a ,, Crystals	per ton	£8	..
a ,, Bichromate, casks.. ..	per lb.	2½d.	..
METALS, &c.			
b Aluminium Ingots, in ton lots ..	per ton	£148	..
b ,, Wire, in ton lots ..	per ton	£294	..
b ,, Sheet, in ton lots ..	per ton	£191	..
p Babbitt's metal ingots	per ton	£43 to £145	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¼d.	..
c ,, Tube (brazed)	per lb.	9½d.	..
c ,, ,, (solid drawn).. ..	per lb.	8¼d.	..
c ,, Wire, basis..	per lb.	7¾d.	..
c Copper Tubes (brazed)	per lb.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	10¼d.	..
g Copper Bars (best selected ..	per ton	£78	..

METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g Copper Sheet	per ton	£78	..
g ,, Rod	per ton	£78	..
e ,, (Electrolytic) Bars ..	per ton	£78	..
e ,, ,, Sheets ..	per ton	£84	..
e ,, ,, Rod ..	per ton	£74 10	..
e ,, ,, H.C. Wire	per lb.	9d.	..
f Ebonite Rod	per lb.	8/-	..
f ,, Sheet	per lb.	5/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	8/-	..
h India-rubber, Para fine	per lb.	3/10 to 3/10½	..
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	50/6	1/5d. dec.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£13	..
g ,, ,, Sheet	per ton	£14 10	..
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£8 12 6	..
d Mica (in original cases) small ..	per lb.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/2	..
o Platinum	per oz.	£4	..
p Silicium Bronze Wire	per lb.	10d. to 1/-	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£137 to £138	£3 10 dec.
g ,, Foil	per lb.	1/6½	..
n ,, Wire, Nos. 1 to 16	per lb.	1/9½	..
p White Anti-friction Metals— "White Ant" brand ..	per ton	£42 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7¼d.	..
j ,, 6 lea. Flax	per lb.	5⅜d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4⅛d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4¼d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£26 15	..

Quotations supplied by:—*a* Messrs. G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Messrs. Thos. Bolton & Sons., Ltd.; *d* Messrs. F. Wiggins & Sons.; *e* Messrs. Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* Messrs. James & Shakespeare; *h* Messrs. Edward Till & Co.; *i* Messrs. Bolling and Lowe; *j* Messrs. ; *k* Messrs. Morris Ashby, Ltd.; *m* Messrs. W. T. Glover & Co., Ltd.; *n* Messrs. P. Ormiston & Sons; *o* Messrs. Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Locality.	Week ending	Receipts for the week. £	Receipts for the week. £*	Total to date. £	Total to date. £*	Miles open.	Miles open. *
Aberdeen	Apr. 4	870	+299	42,236	+10,855	—	—
Birmingham	,, 4	5,045	—269	—	—	—	—
Blackburn	,, 3	737	—250	886	— 254	12½	+1½
Blackpool and Fleetwood	,, 4	268	- 460	2,738	— 331	7½	—
Bolton	Mar. 29	1,686	—194	84,438	+ 7,525	—	—
Bristol	Apr. 3	4,440	—1,026	—	—	28	—
Burnley	,, 4	806	+114	—	—	—	—
British Elec. Trac. Co.:—							
Barnsley District ..	Mar. 27	184	—	1,950	—	—	—
Devonport	,, 27	411	+ 23	4,702	— 34	5	—
Dudley—Stourbridge..	,, 27	772	+102	8,453	+ 823	18½	—
Gateshead	,, 27	888	+154	9,868	+ 2,107	10½	+ ½
Gravesend—Northfleet	,, 27	200	—	2,166	—	3½	—
Greenock—Pt. Glasgow	,, 27	498	+ 48	5,028	+ 504	7½	—
Hartlepool	,, 27	228	+ 0	2,656	+ 523	6½	+2
Kidderminster	,, 27	105	+ 3	1,212	+ 88	4½	—
Merthyr	,, 27	184	— 36	2,107	— 233	3	—
Middleton	,, 27	262	— 93	2,790	— 93	8½	—
Oldham—Ashton ..	,, 27	555	+ 29	6,297	+ 650	8	—
Peterborough	,, 27	119	—	1,157	—	—	—

Locality.	Week ending	Receipts for the week. £	Receipts for the week. £*	Total to date. £	Total to date. £*	Miles open.	Miles open. *
B.E.T. Co. (*continued*)—							
Poole	Mar. 27	270	+ 32	2,937	+ 547	3½	—
Potteries	,, 27	1,704	+254	18,332	+ 623	28½	—
Rothesay..	,, 27	43	+ 14	498	+ 144	—	—
Southport	,, 27	254	+ 57	2,681	+ 1,007	5½	—
South Staffordshire ..	,, 27	826	+108	8,544	— 188	21½	—
Swansea	,, 27	466	— 6	5,346	+ 388	5½	—
Taunton	,, 27	52	— 11	589	— 57	1½	+1½
Tynemouth	,, 27	229	— 1	2,556	+ 287	3½	—
Weston-super-Mare..	,, 25	32	—	909	—	2½	+2½
Wolverhampton Dist.	,, 27	383	+229	4,176	+ 2,893	10½	+8
Yorkshire Woollen Dist.	,, 27	227	—	860	—	6	—
Dover	,, 21	177	+ 8	2,001	+ 49	3	—
Dublin	Apr. 3	4,374	—383	57,007	+ 2,957	46	—
East Ham	,, 4	556	+ 40	25,341	+ 5,008	5	+ ½
Glasgow	Mar. 28	12,643	+1,691	537,424	+19,887	63	+12½
Liverpool	,, 21	9,510	— 5	110,099	+ 5,294	—	—
Newcastle	Apr. 4	3,117	+850	—	—	17	—
Sunderland	Mar. 29	1,061	— 62	—	—	12	—
Central London Railway	Apr. 4	7,122	+486	97,963	+ 5,483	6½	—
City and S. London Ry.	,, 5	3,074	+212	45,040	+ 3,299	6	+1½
Liverpool Overhead Ry.	,, 5	1,583	— 37	21,079	+ 1,590	6½	—

* Compared with the corresponding period of 1902.

MODERN TENDENCIES IN THE UTILISATION OF POWER.*

By J. J. FLATHER.

(*Continued from page* 581.)

A considerable difference of opinion exists as to whether individual motors should be used with each machine, or whether a number of machines should be arranged in a group, and driven from a short line shaft.

There are well-defined conditions to which each system is best adapted, but there are wide limits between which there appears to be no general rule, and we find both methods occupying the same field.

For isolated machines, and for heavy machines that may be in occasional use, the individual motor is particularly well adapted, as it consumes power only when in operation. It is, however, necessary that each motor thus connected shall be capable of supplying sufficient power to operate its machine under the heaviest as well as lightest loads. In certain cases, moreover, the load is liable to very great irregularity, as, for instance, in metal-working planers, in which the resistance offered by the machine at the moment of reversal of the platen is far higher than at other times, and may be so great as to endanger the armature of the motor. Under these conditions it is necessary to use a motor of much larger capacity than the average load would indicate.

Fortunately, with electric motors, the rated capacity is usually less than the safe maximum load, which is determined either by the heating of the conductors tending to break down the insulation, or by excessive sparking at the brushes. For momentary overloads relatively large currents may pass through the coils without injury to the insulation, since the temperature effect is cumulative and requires time for its operation. However, for continuous periods of considerable length it is usually unsafe to operate the motor much above its rated output.

Ordinarily in machine-driving the motor is shunt wound, and the current through the field coils is constant under all conditions of load; but to obtain the best results with that class of machinery in which the load is intermittent and subject to sudden variations, the motor should be compound wound so as to increase the torque without an excessive increase of current in the armature.

In many cases with individual motors, owing to wide variations in power required, the average efficiency of the motor may be very low; for this reason a careful consideration of the conditions governing each case indicates that for ordinary machine-driving, especially with small machines, short lengths of light shafting may be frequently employed to good advantage, and the various machines, arranged in groups, may be driven from one motor. By this method fewer motors are required, and each may be so proportioned to the average load that it may run most of the time at its maximum efficiency.

When short lengths of shafting are employed the alignment of any section is very little affected by local settling of beams or columns, and since a relatively small amount of power is transmitted by each section, the shaft may be reduced in size, thus decreasing the friction loss. Moreover, with this arrangement, as also with the independent motor, the machinery may often be placed to better advantage in order to suit a given process of manufacture; shafts may be placed at any angle without the usual complicated and often unsatisfactory devices, and a setting-up room may be provided in any suitable location as required, without carrying long lines of shafting through space. This is an important consideration, for not only is the running expense reduced thereby, but the clear head-room thus obtained, free from shafting, belts, ropes, pulleys and other transmitting devices, can be more easily utilised for hoists and cranes, which have so largely come to be recognised as essential to economical manufacture.

In arranging such a system of power distribution the average power required to drive is of as much importance as the maximum, for in a properly arranged group system the motor capacity need not be the equivalent of the total maximum power required to operate the several machines in the group, but may be taken at some value less than the total, depending upon the number of the machines and the average period of operation. On the other hand as already shown, the motor capacity of independently driven machines must not only equal the maximum power required to drive the machine at full load, but it must be capable of exerting a greatly increased momentary torque. In any case large units should be avoided, for the multiplication of machines driven from one motor entails additional shafting, countershafts and belting which may readily cause the transmission losses to be greater than those obtained with engines and shafting alone, besides frustrating some of the principal objects of this method of transmission.

As far as the efficiency of transmission is concerned, it is doubtful whether, in a large number of cases, motor-driving *per se* is any more efficient than well-arranged engines and shafting.

As already pointed out, the principal thing to be kept in mind is a desired increase in efficiency of the shop plant in turning out product, with a reduction in the time and labour items, without especial reference to the fuel items involved in the power production.

On account of the sub-division of power which results from the use of many motors, there is less liability of interruption to manufacture, and in case of overtime it is not necessary to operate the whole works, with its usual heavy load of transmitting machinery.

Another advantage is the adaptability to changes and extensions; new motors may always be added without affecting any already in operation, and the ease with which this system lends itself to varying the speed of different unit groups is a very potent factor in its favour.

One serious obstacle to the use of connected motors with machine tools is the difficulty of obtaining speed variation, which is so necessary with a large proportion of the machines in common use. A certain amount of variation can be obtained by rheostatic control—a wasteful method; or by using a single voltage system with shunt field regulation; but the variation in either case is very limited. This, however, may be increased by using a double commutator if space will permit.

The three-wire, 220-volt system offers many advantages for both power and lighting systems, and is very frequently employed. Variations of speed may be obtained with this system by using a combination of field regulation with either voltage, and, in rarer cases, the use of a double commutator motor.

A method which has been used recently with considerable satisfaction involves the use of a three-wire generator, with collector rings connected to armature winding similar to that of a two-phase rotary converter. Balancing coils are used, and the middle points of these are connected to the third wire, which is thus maintained at a voltage half-way between the outer wires. This system is simple and economical, and possesses all the advantages of the ordinary three-wire method; it permits similar variations in speed by field regulation with either voltage; and if still wider ranges are desired a double commutator motor may also be used.

In other recent installations the four-wire multiple voltage system is used, which permits of very wide variations of speed in the operation of the tool. This system gives excellent results and removes one of the objections urged against direct-connected motor-driven tools, namely, that such machines are not sufficiently flexible in regard to speed variation, and that such variation can only be obtained by throwing in resistances which cut down the efficiency of the motor, or by varying the strength of field which reduces the torque.

The multiple voltage system, however, has some serious disadvantages. It cannot usually be operated from an outside source of power without rotary transformers; the generating sets and switchboard are complicated and the total cost of installation is expensive; yet with these drawbacks the system is growing in favour, as it has manifest advantages which outweigh the objections.

The storage battery has been used to some extent to obtain multiple control and is suggestive of interesting possibilities, but in its present form it is not altogether desirable for machine tools.

In many of the larger sizes of certain metal-cutting machines it is probable that marked changes will be produced in the immediate future, and the indications are that direct-connected motors with wide variations of speed and power will be incorporated in the new designs.

The recent improvements in the manufacture of certain grades of tool steel have shown indisputably that the present designs of machine tools are not sufficiently heavy to stand up to the work in order to obtain the economy of operation which results from the use of such steels. Higher speeds, heavier cuts and greater feeds may be obtained if the machines will stand the strain, but in most cases the capacity of the machine is not commensurate with the ability of the tool to remove metal. With cutting speeds of 100 to 200 ft. per minute, it is evident that the power requirements will be much greater than for the ordinary machines of to-day, which have a cutting speed of from 10 to 30 ft. per minute. As an illustration of what can be done with these new tool steels the speaker was recently shown some steel locomotive driving-wheels which had been turned up in 2 hours and 40 minutes, whereas the regular time formerly required was not less than 8 hours. In this case even better results could have been obtained, but the belts would not carry the load.

Here then we find an interesting field for the direct-connected motor with ample power and speed variation for any work which it may be called upon to perform.

While the preference is easily given to continuous-current motors for the purposes of machine driving, yet we find alternating current motors used to a considerable extent, the proportion of motors in service being about one to five in favour of the continuous-current motor. Both synchronous and induction motors are employed, but the advantages possessed by the latter cause this type to be preferred, although in long-distance transmissions, both types should be used in order to obtain satisfactory regulation. As shown by Mr. H. S. Meyer,* the induction motor can readily be worked at variable speeds, which is accomplished in three different ways: (1) by rheostatic control, which is decidedly the cheapest and easiest method to manipulate; (2) by varying the impressed voltage, which, however, necessitates the use of a transformer or compensator with variable ratio; this is very inefficient at the lower speeds, and can only be used under certain conditions; and (3) by altering the number of poles, which is mechanically very complicated, but where the speed variation is only one-half or one quarter, it may be used efficiently.

One serious disadvantage met with in all induction motors is the lag produced by self-induction, and its reaction on the circuit. This lag is particularly unsatisfactory with intermittent service, such as machine driving, where the motors have to run under light and variable loads; in such cases the power factor is probably not over 60 or 70 per cent.

* Address of the chairman of Section D, Engineering and Mechanical Science, and Vice-President of the American Association for the Advancement of Science. Read at the Washington meeting, December 29th, 1902.

* *London Engineering*, April 19th, 1901.

Reference has been made to the use of compressed air and its facility of adaptation to various requirements, but it is evident, from an inspection of some of the devices in use, that enthusiasm for new methods, rather than good judgment, has controlled in many of its applications.

For some years compressed air was used only in mines, where it produced marked economies in underground work. Later, compressed air was introduced into manufacturing lines, and to-day its use in railroad and other machine shops, boiler shops, foundries and bridge works is being widely extended. In the Santa Fé Railroad shops at Topega there are over five miles of pipe in which compressed air is carried to the different machines and labour-saving appliances throughout the works.

In such shops air is used to operate riveting machines, punches, stay-bolt breakers, stay-bolt cutters, rotary tapping and drilling machines, flue rollers, rotary grinders, rotary saw for sawing car roofs, pneumatic hammers, chisels and caulking tools, flue welders, boring and valve-facing machines, rail saws, machine for revolving driving wheels for setting valves, pneumatic painting and white-washing machines, dusters for car seats, and the operation of switching engines about the yard. It is also used in the foundry for pressing and ramming moulds, and for cleaning castings by the sand blast; but it greatest field of usefulness is its application to hoisting and lifting operations in and about the works.

New applications of compressed air are constantly being made, and each new use suggests another. This has a tendency to increase the number of appliances which are intended to be labour-saving devices, but in many cases the work could be done just as well and much more cheaply by hand.

A case in point is seen in an apparatus which was at one time in use on one of our prominent western roads. It was a sort of portable crane hoist, which could be fastened to the smoke-stack of a locomotive, whereby one man could lift off the steam chest casing. The hoisting apparatus weighed about twice as much as the steam chest, and took three men to put it up. When piece work was adopted, two men easily lifted off the steam chest, and this "time and labour saving device" was relegated to the scrap heap.

While compressed air has been used to some extent for inducing draught in forge fires, it is unquestionably a very expensive method. Tests to determine this show that it costs 25 times as much to produce blast in that way as it would with a fan.*

The success and economy which has attended the use of compressed air in so many lines of work has led to its adoption in fields which are much better covered by electrically operated machines. While compressed air has been used under certain conditions very satisfactorily to operate pumps and engines, printing-presses, individual motors for lathes, planers, slotters, dynamos and other work, it does not follow that it is always an economical agent under these various uses, or that other methods could not be used even more satisfactorily in the majority of cases.

It has been proposed to use individual air motors in machine shops and do away with all line shafting, except possibly for some of the heavier machinery. This use of compressed air seems entirely outside the pale of its legitimate field; the general experience thus far indicates that rotary motors are not at all economical and generally are not as satisfactory as electric motors.

Exceptions are to be found in the small portable motors for drilling and similar operations, to which electricity is not at all adapted and where compressed air has been found to give excellent results. The saving obtained by the use of such portable drills as compared with a ratchet drill is very marked.

Although these tools are very successful they are still rotary motors, not exempt from some of the objectionable features which seem to be inseparable from them. It is not surprising, therefore, to find a tendency to employ reciprocating pistons and cranks in these portable machines, and we note such tools weighing only 40 lbs. capable of drilling up to 2½ in. diameter.

While the field is to some extent limited, yet the uses of compressed air are certainly not few, and in many lines of work marked economy results from its use.

In most cases no attempt has been made to use the air efficiently; its great convenience and the economy produced by its displacement of hand labour have, until recently, been accepted as sufficient, and greater economies have not been sought.

In the matter of compression we still occasionally find very inefficient pumps in use, but manufacturers generally have found that it pays to use high-grade economical compressors. The greatest loss is that in the air motor itself. In a large number of cases it is impracticable or, at most, inconvenient to employ reheaters, and we find very generally that the air is used at normal temperature for the various purposes to which it is applied.

To obtain the most satisfactory results the air must be used expansively, but usually where the demand for power is intermittent no attempt has been made to reheat the air, and as a result the combined efficiency of compressor and motor is quite low, varying in general from 20 to 50 per cent. While low working pressures are more efficient than high, the use of such pressures would demand larger and heavier motors and other apparatus which is undesirable.

The advantages of higher pressures in reducing cost of transmission are also well recognised, and the present tendency is to use air at 100 to 150 lbs. instead of the 60 or 70 lbs. of a few years ago.

By reheating the air to a temperature of about 300° F., which may often be accomplished at small expense, the efficiency is greatly increased; in some cases this has been shown to be as high as 80 per cent. While the lower pressures are yet more efficient, the loss due to higher compression is not serious.

If air be used without expansion it will be seen that there is a material loss in efficiency; but, on the other hand, if it be used expansively without reheating, trouble may be experienced, due to the drop in temperature below the freezing point. If moisture be present this will cause the formation of ice, which may clog the passages if proper precautions are not taken to prevent it. The low temperature will not in itself cause trouble; if, therefore, the moisture which the compressed air holds in suspension be allowed to settle in a receiving tank, placed near the motor or other air apparatus and frequently drained, less trouble will be experienced from this cause.

(To be continued.)

* *Proc. Western Railway Club*, 1898.

ROYAL COMMISSION ON LONDON TRAFFIC.

Sir David Barbour presided at the Caxton Hall, Westminster, on 3rd inst. over the fourth meeting of the Royal Commission on London Locomotion, when evidence was given by Mr. A. C. Morton, Chairman of the Streets Committee of the Corporation of London. Witness stated that all matters affecting the streets of the City were referred by the Corporation to that Committee, including all Bills embodying schemes for railways, tramways and other questions of locomotion. The reference to the Royal Commission had been considered by the Committee, and on their recommendation the Court of Common Council passed the following resolution:—"That it is desirable to have a new and independent authority or tribunal to be approved by Parliament, subject to the rights and privileges of local and road authorities being preserved." The Corporation had not itself promoted any tramway or railway in the City, but during the past 10 years it had opposed, or had been otherwise concerned in, a large number of railway and tramway Bills. Witness proceeded to give instances showing the necessity for a tribunal to deal with such matters, and referred to the unavailing efforts of the Corporation to get Ludgate Hill Station improved and the approach to the Great Western and Metropolitan Railway Co.'s underground station at Smithfield covered in. Another instance was the case of the suggested subway communication between the booking offices of the Central London Railway station at the Bank and the City and South London Railway station in King William Street, which the companies had agreed to construct, but which must await Parliamentary sanction. Owing to the suspension of the Central London Railway Bill, which contained provisions for the purpose, this necessary work was indefinitely delayed. Such instances would not have occurred had such a tribunal as that in contemplation been in existence, to which recourse could have been had with a minimum of delay and expense. Another reason for the appointment of a tribunal was the uncertainty created by varying and inconsistent decisions upon the same subjects. For instance, in some of the earlier Acts authorising tube railways, confluent junctions were sanctioned. In 1901 the Joint Committee of both Houses of Parliament, after full inquiry, came to a decision strongly against such junctions. One of the Bills at present under consideration by Parliament proposed to authorise such a junction, so that, although the parties interested have already gone over all the ground involved in the consideration of this question, they were now put to the expense and trouble of going over it again, and it was possible that the decision would be different. These varying decisions would, in his opinion, be done away with, or, at all events, greatly mitigated by the establishment of a tribunal of a permanent character, whose decisions would be based upon principles which would have to be recognised as essential to the success of any applications made for powers, so that, even if the same schemes were repeatedly the subject of similar applications to the tribunal, the matters to be discussed would be considerably limited by the necessary recognition of the principles so laid down, with a consequent saving of expense. It had been decided that, as a general principle, the Railway Commission was bound by its previous decisions.

The Chairman: The general tenor of your evidence is that the present system of obtaining Parliamentary sanction to schemes causes great trouble and expense, and does not give very satisfactory results?—That is so.

And that the expense is prohibitive in many cases, both in respect of promoters and opposition?—Yes.

Continuing, Witness said that, with regard to the position of the local authorities, he was of opinion that in the City of London, particularly, where there were no less than 23 railway stations, the Corporation, who were the police as well as the local authority, should have absolute control. Most of the promoters of underground electric railways had recognised this necessity, so far, at least, as the public streets were concerned, and had agreed that the surface of the streets should not be broken up or interfered with without the consent of the Corporation.

The Chairman: It is the regular practice of these companies to consent to the control of the Corporation?—Yes; and it is put in the Bills. They are called City clauses.

So that the streets cannot be broken up or interfered with without the consent of the Corporation?—Yes; we make very stringent regulations as to when they can be opened up and how.

Proceeding, Witness said that the companies had also agreed to clauses under which the Corporation took power to require them to make subway communication with adjacent railways wherever the Corporation deemed it necessary. He was of opinion that the powers of control by local authorities over railway companies and other commercial undertakings should be considerably strengthened, and that in all matters affecting the public streets such control should be absolute. Inasmuch as such authorities acted only in the public interest, he considered that all expenses incurred by them in

relation to the undertakings of such companies, such as, for instance, the cost of opposing Bills in Parliament, expenses of arbitration, &c., should be borne by the companies giving rise to them, except in cases of vexatious opposition. Such a provision would do much to modify the proposals of such companies from the public point of view, by inducing them in every way to consider the wishes of the local authorities.

The Chairman: You recognise that the case of tramways is much greater in the City than in the outlying districts. Would you allow the outside local authorities to retain the right of veto?—So far as my experience goes, it has been exceedingly useful. It enables them to get terms without the expense of going to Parliament.

If they have the right of veto they can dictate their own terms?—Yes.

Witness was of opinion that with regard to the composition of the suggested tribunal, it should be composed of five independent persons. He suggested that the chairman should be a man of repute as a business man; one member should be an engineer of repute, accustomed to deal with matters of locomotion and street traffic; and a third member should be a lawyer of experience in similar matters. The decisions of the tribunal should be final.

You do not suggest that the decisions should be reviewed by the Board of Trade?—No; whatever they decide should be final.

What do you think of the suggestion that the decisions of the tribunal should be laid on the table of the House of Commons, and should become law after six weeks, unless Parliament saw fit to interfere?—I think it would be a waste of time.

Further examined, Witness said his Committee had not considered whether the tribunal should be paid, or whether they should devote the whole of their time to the work. Personally, he thought they should. He thought it would be wrong if an engineer were appointed a member of the tribunal, and continued the practice of his profession in London. The tribunal should, in addition to considering schemes, make reports periodically on London traffic. They could not consent in the City to the tribunal themselves carrying out or supervising work.

By Sir J. Dimsdale: He asked for the local authorities' right of veto with regard to tramways.

Sir Francis Hopwood: Is it the deliberate policy of the Corporation not to become promoters of tramways?—Undoubtedly. We have such a small area that we could not work tramways ourselves.

As a matter of fact, the Corporation has not suffered from the fact that tube schemes have been considered on their merits?—No.

I do not see, therefore, why you should want to retain the right of veto?—I only say that about tramways.

But the City are not much interested with that?—They are very much interested in keeping them out of the City.

The London County Council have suffered from the veto?—Yes, but I cannot say that they have unjustly suffered.

You think that the sub-local authority rather than the L.C.C. is the best judge as to whether a road has need to be widened?—Yes.

Replying to Mr. Gibb, Witness thought that the local authority knew much better than Parliament whether a tramway was required.

In further cross-examination, Witness said that Parliamentary Committees changed their opinions from year to year, and there was no continuity of principle.

The Commission adjourned.

"ANGOLD" ARC LAMPS AT HORNSEY.

At the beginning of March the new public electric lighting system of the Hornsey District Council was quietly switched on. The arc lamps are a part only of the whole electric lighting scheme of the

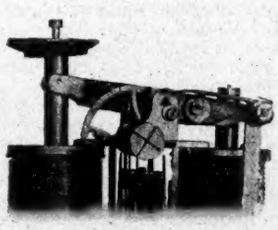


Fig. 1.—Mechanism after Arc has been Struck.

Council, but there are several novel points connected with them and their gear which are of special interest apart from the rest of the system.

There are at present 50 arc lamps installed, these being connected in series of five across from the neutral to either one of the outers of the 480-volt three-wire system of distributors. Each lamp has a special equivalent resistance and cut-out fitted in its post, with a two-way switch, which isolates the lamp and throws in the equivalent resistance. In addition, each of the two end posts of the series are provided with a make-and-break single-pole switch, and the second post from the neutral contains the line resistance.

The contract for the arc lamp-posts, switch-gear, &c., was obtained by the General Electric Co., Ltd., and the arc lamps are of their improved "Angold" band-brake pattern, single-carbon type, burning for 22 hours with a current of 10 amperes, somewhat similar in construction to the 240 recently installed at Battersea. Our views show these as suspended at the side of the road by means of the "Angold" patent automatic clutch and contact gear, which will be described hereafter.

The mechanism of the lamp, which has not previously been described in detail, is of considerable interest on account of the fact that rubber pads for the brake band are employed in a patented

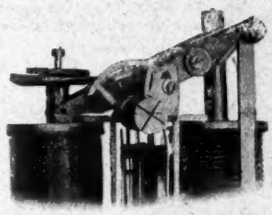


Fig. 2.—Pawl Engaging Tooth of Sector and Releasing Brake.

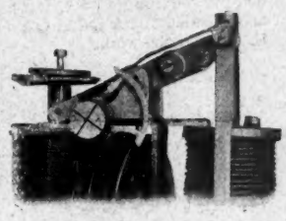


Fig. 3.—Mechanism when Rubber Pads are worn away.

arrangement, which gives a steady feed and compensates for the wear of the rubber. The brake drum carries the band furnished with rubber pads, one end of which is attached to a pulley controlled by a spiral spring in tension, and the other end is hooked on to a rocking frame controlled by the two cores. The tension of the spring takes up any slack of the band as well as any slack that may be caused by wear of the pads; this keeps the brake in action, and maintains the position of the band relatively to the drum. Regulation is effected by a pawl controlled by the rocking frame, and which engages a toothed sector mounted concentrically on the pulley to which the band is attached. When the mechanism is at the predetermined feeding point, the pulley comes into action, the spring can no longer exert a pull on the brake band, and feeding takes place. When compensation is necessary, the pawl rotates

Fig. 4.—"Angold" Differential Cut-out and Resistances in Lamp Post.

further before all the slack is taken up; consequently, when the feeding point is reached, the pulley engages a different tooth. The regulation remains constant and independent of wear, because the release of the brake always occurs when the mechanism takes up a certain position. The action is explained by figs. 1, 2 and 3, and it is claimed that with this arrangement the lamp possesses important advantages over other mechanisms, the regulation being so good that bad carbons will not cause more than 2 volts variation, and that when the lamp is properly erected no further adjustment of any kind is required.

The patent suspension gear is shown by fig. 5. The crown of the lamp is mounted with an insulated plug, provided with two spring-controlled catches whose normal position is horizontal, but which can be depressed either upwards or downwards. When the lamp is drawn up by the winch inside the post, the catches are depressed downwards inside the socket, but on reaching the first increased diameter they open out as shown in fig. 5, and support the weight of the lamp on the ledge. If it be required to lower the lamp, it is first raised a little, so that the catches can open out into the horizontal position in the second increased diameter of the socket,

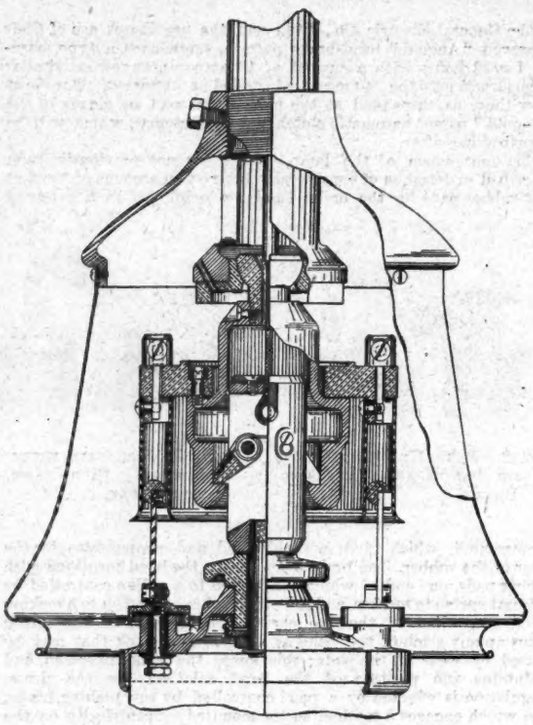


Fig. 5.—Angold Lamp Suspension Gear.

G.E.C. "Angold" Arc Lamps, Archway Road. Lowering Lamp from Patent Suspension Gear.

and if the winch be now released the catches will be depressed upwards, like an umbrella turned inside out, as they pass the two smaller diameters of the socket, springing into the horizontal position when they emerge from the bell mouth. The whole socket is supported on a ball-joint, through which a steel wire passes, the cables being brought out into the protecting dome at a point above and connected to the concentric contact rings, which are mounted on a china ring supported on the socket; the whole arrangement is weathered by a copper spinning and a cast-iron dome. The crown of the lamp has, in addition, two insulated copper brushes which make contact with the concentric rings, no matter what the position of the lamp when drawn up.

Fig. 4 shows the arrangement of the gear inside the second post from the neutral. The top cover contains the equivalent resistance, the cast-iron box, the cut-out, and the bottom cover the line resistance. The other posts are without the last-named, and the two end posts have an additional switch, as previously described.

The patent differential cut-outs represent a great advance over previous apparatus designed to protect arc lamps on high voltage circuits; in the latter the equivalent resistance is brought into circuit when something has already gone wrong, whereas in the G.E.C. pattern its normal connection is in circuit, and it is cut out only when everything is in order. The series coil is in series with the lamp, and the two coils pull against each other; the advantages of this arrangement will be seen when it is pointed out that with the usual arrangement of the series coil in the equivalent resistance circuit, and the shunt across the latter's terminals, the two magnetising forces rise and fall together, and, therefore, there is no differential action at all. In the G.E.C. cut-out, the voltage of the circuit may be safely reduced slowly to *nil* without causing the contacts to make and break, and thus burn up. A positive circuit is also provided independent of the condition of lamp or cut-out owing to the resistance being left in parallel with the lamp when the latter is switched off; therefore, contact being already made, if any lamp be without carbons, or if they are stuck apart, the full voltage of the circuit is not thrown on to the shunt coils of the lamp and its cut-out when the lamp is switched on. The current will at once pass through the equivalent resistance, and will continue to do so until the carbons touch, thus protecting the shunt coils of the lamp and maintaining the other lamps in action.

As will be seen from our illustrations, the posts are of unusually handsome design. The wire from the winch passes up through the post and bracket arm inside a copper tube, and therefore there is no danger of the cables being interfered with.

We understand that the installation has given the greatest possible satisfaction owing to the steady burning and good regulation of the lamps. The whole arrangement has been erected to the specification of the consulting engineers, Messrs. R. W. Hammond & Son, to whom our thanks are due for permission to publish this report, and we also have to thank the borough electrical engineer (Mr. Staniland) and the General Electric Co., Ltd., for the information they have placed at our disposal.

SOUTH AFRICAN NOTES.

[From Our Special Correspondent at Johannesburg.]

Klerksdorp, Transvaal.—A proposal to light the town with electricity was recently presented to the Health Board. Nothing was decided on, but the offer was a liberal one, and was favourably entertained by the members. The matter has been referred to the Government to consider the advisability of giving a concession.

Standerton, Transvaal.—The water supply of the town has been engaging some attention, and a Commission appointed to inquire into the matter was of the opinion that the most economical plan for providing the power at the pumping station was one of electric transmission, a power house being erected at a suitable point near the railway. It was therefore decided to postpone the question of erecting an independent electricity station and the whole will probably be erected on one site.

Things that don't Happen at Home.—One morning recently there was found to be a contact on the telegraph wires between Potchefstroom and Klerksdorp, and a linesman was despatched to ascertain the cause. About four miles from Potchefstroom he found that an enormous vulture had become entangled in the wires, and in its struggle to release itself the bird had brought four wires into contact. It was dead when found.

Durban, Natal.—The Government being dissatisfied with the Durban municipal telephone service, are installing a separate system of their own to connect all the local Government departments, also to place all the cargo sheds in communication with the wharfmaster's office. The exchange will be in the new Central Harbour Department offices when completed. The system will be ultimately connected with the Government trunk service, which is to embrace Durban, 'Maritzburg, and the principal towns in the Colony.

Bulawayo, Rhodesia.—Only one tender has been received at Bulawayo for the tramway scheme, and in the event of none being received in London this tender will by considered by the Public Works Committee, and not by the London agents.

Pietermaritzburg, Natal.—Mr. F. Walton Jameson, the borough engineer of the city, complains of the lethargy of British and Continental manufacturers with regard to the delivery of the material for the electric tramways. The power station is all but completed. The real delay, however, is caused by a Belgian firm, who have the contract for the rails but have not yet commenced delivery. The borough engineer hoped and promised to have the cars running within nine months.

The Council have decided to spend £6,340 on spare plant and materials, to be able to deal promptly with breakdowns. It was

also decided to have the tenders which were called for in January for £5,533 worth of cables and feeder boxes, opened in London. This resolution was strongly opposed, one of the Councillors remarking that it practically amounted to saying to the agents, "Here is our money; spend it for us!" However, the resolution was passed.

Porges Randfontein G.M. Co., Randfontein, Transvaal.—The manager of this company was charged before the resident magistrate with allowing live electric wires to be placed in an exposed position, and thereby causing the death of a Kaffir, named Fifteen, by electrocution. From the evidence for the defence it appears that the natives are in the habit of stealing the wire to bind their knobkerries, &c., with, and although punished and constantly warned of the danger, they persist in their peculations. This particular "boy" actually attempted to steal wire from the switchboard, although the engine room was "out of bounds." The case was, of course, dismissed. The system is alternating current at 550 volts pressure.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"Pembroke" writes:—"I take a supply of electricity from an Urban District Council. The account is supposed to be rendered quarterly. For the last two quarters this has been done, but for the October quarter no effort was made to collect, the account being rendered again with the bill to December 31st; this account was sent me by post, and although the Council have a collector appointed, he has never made an application for the money except by post. Some days ago the clerk to the Council wrote me that unless the account was paid at the Town Hall to the collector, the supply would be discontinued on March 28th. I telephoned down to him that I was going out of town, and had left the money at home all ready in an envelope, and if the collector sent down it would be handed to him. He has not done so, and they have again threatened to disconnect. The clerk to the Council has just telephoned to me, and he says to avoid any trouble he will send down his own clerk. I should like your opinion as to whether, seeing that the electricity is delivered to me at my house from the electricity works, I am under a legal obligation to take the money to a third place—viz., the Town Hall—or if I am right in saying that their collector must call for it. And if the former is right, what is the proper course to adopt should they seek to disconnect my service?"

*** There is nothing in the Electric Lighting Acts to prescribe any method for paying rent. Sec. 21 of the Act of 1882 provides that if any person neglects to pay any charge for electricity due to the supplier in respect of the supply of electricity the supplier may cut off such supply, and for that purpose may cut or disconnect any electric line or other work through which electricity may be supplied, and may also keep the supply cut off until the arrears are paid.

The proper way to pay the account would be to send it by post, but it is impossible to conceive that the Corporation are entitled to compel a consumer to actually bring his money to the Town Hall in the manner suggested. If they were to cut off his supply after a telephone message to the effect that the money was waiting for them at his house, it would afford ground for an application to the Court for an injunction.

"Supply" writes:—"We should very much like your opinion on the following subjects:—(1) We are about to build some new business premises, and on either side our neighbours are users of electricity. We are thinking of putting down a private plant for our own purpose. One neighbour occupies premises owned by us, but the other occupies his own property. We calculate that we should require about 150 amperes 230 volts altogether. The Corporation of the Borough are suppliers of electricity. The thing we want to know is whether we can be prevented by them from supplying our neighbours? If so, can any of your readers tell us if they have had a similar case to deal with, and what is the best course to adopt. We have considered that it would overcome any difficulty by each of us putting so much capital into the plant, and thus forming a small company for our own private benefits. (2) We should also be glad to hear as to whether a Corporation can refuse to supply current through a change-over switch."

*** It has frequently been pointed out in this column that there is nothing in any of the Electric Lighting Acts to prevent a private person or company laying down an electrical installation and supplying electricity to his neighbours. This rule holds good, although there may be a municipal supply available. In other words, no local authority or private company which obtains a provisional order has any monopoly in the supply of electricity.

It is true that by obtaining a provisional order certain rights and privileges are acquired, but none of these can interfere with the right of a private person to supply himself and his neighbour when the private installation does not involve the use of overhead wires or the breaking up of streets. With reference, therefore, to question (1), it will not be necessary for "Supply" to form any company for the purpose suggested, or to obtain the leave of or even consult the Corporation with reference to his proposed installation. Before laying down his plant, however, he would do well to purchase and peruse a copy of the "Regulations prescribed by the Board of Trade under Sec. 4 of the Electric Lighting Act, 1888," which may be had for a few pence from Messrs. Eyre & Spottiswoode, London, E.C.

With regard to (2) there is no express rule or decision on the point, but those who supply electricity under a provisional order are not entitled to interfere with, or in any way control, the way in which electricity supplied by them is used, but no one is allowed to use his supply in such a manner as to unduly interfere with the supply to other persons. So long as the switch in question does not have this effect, it is conceived that a consumer may use it.

THE APPLICATION OF THREE-PHASE MOTORS TO THE ELECTRICAL DRIVING OF WORKSHOPS AND FACTORIES.

By A. C. EBORALL.

(Abstract of Paper read before the Society of Arts, April 1st, 1903)

A three-phase installation for most classes of work is preferable to a continuous-current one, owing to its flexibility, reliability and economy in cost of installation and maintenance. Its ability to stand overloading and rough treatment cannot be equalled by continuous-current machinery. Its only disadvantage is when *economical* speed regulation is required. This is the weak point of three-phase working. For small powers, and when large starting torque is not required, the short-circuited squirrel-cage motor is an ideal one for constant-speed work. By making the end connections of appreciable resistance, such as by zigzagging them, the starting performance is improved. A curve is shown of the performance of a motor with short-circuited rotor, specially designed for severe starting conditions. Without any starting resistance in circuit, the motor will exert 2·1 times the full-load torque when taking a starting current equal to five times the full-load current. Curves are also given of a motor of the same type, directly coupled to a centrifugal machine. (These were given in the Elec. Rev., January 9th, 1903, p. 51.)

The starting current was about 4½ times the full-load current, the power factor starting at 60 and rising to 91 per cent. at full load. An important advantage of three-phase work is the fly-wheel effect, one motor assisting in the starting up of another by putting current back into the line on a sudden fall of voltage.

With a properly arranged starting transformer, the starting currents may be reduced to twice the full-load currents; but it is important to remember that the output varies with the square of the pressure at the terminals. For motors therefore which require a starting torque equal to or greater than full-load torque, and in which the starting current must be kept within reasonable limits, the full stator pressure must be employed, and a starting resistance inserted in the rotor circuit. This, of course, means a wound rotor with slip rings.

By this means not only is the starting current kept down, but the power factor at starting, attains a value approximating that when the motor is well loaded. The curves in fig. 1 illustrate the relative starting performances of continuous-current and three-phase slip-ring motors, the motor being one of 13 B.H.P. at 500 volts.

The following tables give the efficiencies of motors of various sizes at different loads:—

Motors with Short-Circuited Rotors—200 v., 50 ~, 1,500 r.p.m.

Rating in B.H.P.	Power factor per cent. at full load.	Weight in pounds.	Efficiency per cent.		
			Half load.	Full load.	50 per cent. overload.
1	82	143	79	81	73
2	85	194	81	82·4	79
3	85	265	84	86·4	85
5	88	352	89	88·3	87

Motors with Slip Rings—200 v., 50 ~.

Rating in B.H.P.	Speed at full load.	Efficiency per cent.			
		Quarter load.	Half load.	Full load.	50 per cent. overload.
7	1,440	63	78	86	86
9	1,440	65	80	88	87
14	960	68	82·5	89	88
18	960	70	84	89	88
25	960	71	85	90	89
30	960	72	86	90	89
45	960	73·5	87·5	91	89·5
60	725	75	88·5	92	90
90	725	77	89	92	90

Note.—(1) All the above values are the average of the figures obtained on test from many different motors; all the motors were built for 200 volts and 50 cycles. (2) The temperature rise after a run of six hours at full load does not exceed 80° F. for any motor.

For some classes of work, such as cranes, elevators, yard locos., &c., speed regulation is necessary, and in such cases the slip-ring type of motor is essential, as the short-circuited type for the sizes given above, will fall out of step if overloaded by 60 or 100 per cent. of their normal rating. With the slip-ring type of motor the speed may be varied by inserting resistance in the rotor circuit, and, for all speeds, the current and power factor are approximately constant. The conditions are analogous to those in a shunt-wound continuous current motor regulated by resistance in the armature circuit.

Generally speaking, economical speed variation is of minor importance in workshops and factories, as the shafts are driven at practically constant speed; and in machine shops only the cranes need considering from a speed regulation point of view, and the difference in efficiency in this matter between three-phase and continuous-current motors would be inappreciable in the coal bill. For travelling cranes, the motor for the cross traverse may be of the short-circuited rotor type. A number of tables of powers for various classes of machine tools, based upon tests and experiments made by Mr. Lasche, of Berlin, are given, but these are, of course, equally applicable to continuous-current working.

For textile mill driving three-phase motors can be used with the best results, and meet the conditions better than continuous-current motors do.

For cotton and woollen mills the best arrangement is to drive groups of machines from one motor; for silk weaving individual driving of the looms is the ideal method. Saving in space, absence of shafting, economy in cost of buildings and in running expenses would result from electrical driving. The usual speed of a line shaft driving looms is 170 revolutions per minute. From each shaft 20 looms are driven, requiring 6—7 B.H.P. on the shaft. An ordinary silk weaving loom takes 0·25-B.H.P., and a Jacquard loom about 0·5 B.H.P.

A special arrangement of partially suspended motor in which the weight of the motor assists in keeping the belt taut, is described.

Short circuited rotors may be used, and started practically light by moving them forward on the slide rails until full speed is got up.

In an electrically-driven cotton spinning mill in Ghent, it was found that the following powers were required for four mules:—

			Max. H.P.	Av. H.P.
No. 1 with	672 spindles at	7,600 r.p.m. ...	20	13
No. 2 „	672 „	„ 7,600 „ ...	18	9
No. 3 „	684 „	„ 7,800 „ ...	15	9
No. 4 „	684 „	„ 7 800 „ ...	15	9

The average power of a 35-H.P. motor when driving the four mules was 19, and the maximum 32 B.H.P.

Notwithstanding a heavy fly-wheel on the motor, the fluctuations in power were considerable, but the variation in speed of the motor (three-phase) did not exceed 1·5 per cent. above and below the mean speed.

In conclusion, stress is laid on the following points bearing on the satisfactory and economical working of a three-phase installation for power purposes.

1. The pressure drop in the generators should not exceed 16 to 18 per cent. from no load to full load, at constant speed and excitation, according to size, the full-load power factor being taken as 80 per cent. High engine speed is favourable to good performance in this respect.

2. The power factor of the motors should be as high as possible over a wide range of load; above 3 H.P. this should be not less than 80 per cent. from half load up, and a flat power-factor curve over the working range should be insisted on.

3. The efficiency curve should be as flat as possible over the working range of load.

4. A proper starting performance should be insisted on, and short-circuited rotors should be installed with discretion in the larger sizes.

In opening the discussion, the chairman, Prof. Perry, complimented the lecturer on the fairness with which he had compared the relative advantages of continuous and three-phase motors. In referring to the losses which take place in mechanically-driven systems, he put the losses in cotton mills at 50 per cent. The power companies now springing up in various parts of the country would do a great deal to popularise electrical driving of workshops, mills, &c. The fly-wheel effect referred to in the paper was a new idea to him. He asked for the comparative weights and costs of continuous and three-phase motors.

Mr. Frank Broadbent agreed with the lecturer that for many classes of work the three-phase motor had the advantages of simplicity and ability to stand the rough usage not possessed by the continuous current type.

On the question of speed regulation, however, he thought the author of the paper had not given full credit to the latter type. Saving in power was not everything. It depended largely upon the relative cost of power to the cost of the product.

In a machine tool shop this was but 5 or 10 per cent, and the saving effected in fuel costs only would not pay for the interest and depreciation on capital outlay of an electric motor installation.

The wonderful control of the speed possible with continuous current motors resulted in very great increases in the output of the machine tools, and this consideration far outweighed the fuel saving.

In works such as printing offices, both great economies and increased turnover are possible with continuous current motor-driving, and here the three-phase motor is at a disadvantage.

Referring to cotton mill driving, Mr. Broadbent failed to see how any very appreciable economy could be effected, as the total losses were not more than about 25 per cent.

By sub-dividing the power, the speed variation of the individual motors would be much greater than that of the main driving engine, on which the load was practically constant, and he considered the 1½ per cent. up and down, as mentioned by the lecturer, would be considered much too great by Lancashire spinners. He asked if it would not be better to use synchronous motors rather than motors of

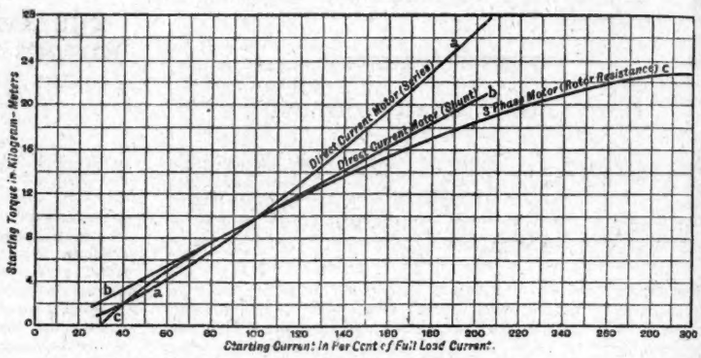


Fig. 1.—Relative Starting Performance of Direct Current and Three-phase Motors having similar Ratings.

the induction type for this purpose. They could all be excited by a special exciting circuit, and would all start up automatically with the main engine, and the speed would be synchronous with that of the main generator, which would be almost absolutely constant. The fly-wheel effect of such a system would be very great.

Mr. Madgen, in referring to the large power scheme in which he is interested, lamented the fact that it was necessary to distribute both three-phase and continuous currents, or continuous only, although generating three-phase, owing to the unsuitability of the latter for tramcar work. Could the lecturer tell them how soon they might expect to be able to use three-phase currents for trams.

Other speakers mentioned the advantages of three-phase working for long-distance transmission, but this was outside the scope of the paper.

Mr. Eborall, in replying, said, referring to Prof. Perry's query, that in large sizes both the weight and the cost of three-phase motors are less than the continuous. He did not agree with Mr. Broadbent's view that synchronous motors were preferable for cotton mill driving. He thought the extra complication would be detrimental, and that the speed of induction motors was sufficiently constant.

In reply to Mr. Madgen, Mr. Eborall said it would be a long time before three-phase tramcar work would be possible, but there was no difficulty as regards light railways, where frequent starting and stopping was not so necessary.

WOLVERHAMPTON ELECTRIC TRAMWAYS.

Mr. Shawfield's report respecting the working of the Lorain surface contact system of electric traction has not yet been officially published. The Wolverhampton *Express* and *Star* was, however, able on Thursday evening in last week to publish a very full summary of the document. Mr. Shawfield, at the outset, states that when the question of the adoption of the Lorain surface contact system was first considered by the Committee, he could not undertake to express any opinion as to its merits or demerits until he had seen the system in commercial operation for at least one year "under the ordinary conditions of traffic and climatic variation that exist in Wolverhampton." After a reference to the compact which the Corporation entered into with the Lorain Steel Co., who offered to equip 11 miles of single track with their system, and to allow the Corporation to commercially operate the same for one year, and at the end of that period come to a definite decision as to the acceptance or rejection of the system, the report goes on to state that the experimental mile on the Bilston road was opened for traffic on February 6th, 1902; it was commercially operated by the Corporation for a period of 30 days, and as the results obtained were considered satisfactory, official instructions were given by the Corporation to the Lorain Co. on February 14th, 1902, to proceed with the equipment of the remainder of the 11·375 miles of single track, in accordance with the terms of the contract.

The following table gives the total length of line in operation, the average number of cars in service, and the total car-miles run for each month from February, 1902, to February, 1903, inclusive:—

Month.	Length of line in operation.	Maximum cars in service.	Average No. cars in service.	Total car-miles.	Car-miles per mile of single track.
1902.	Miles single track.				
February ..	1·8	3	2	3,298	1,798
March ..	1·8	3	2	4,683	2,573
April ..	1·8	3	2	4,441	2,467
May	5·178	11	7	16,062	3,105
June.. ..	8·377	12	10	24,968	2,897
July	8·377	16	13	30,257	3,613
August ..	9·777	20	16	39,154	4,004
September ..	11·063	22	19	41,920	3,789
October ..	11·063	22	19	46,544	4,199
November ..	11·063	22	15	41,139	3,712
December ..	11·063	19	15	45,363	4,094
1903.					
January ..	11·063	20	16	48,502	4,376
February ..	11·063	21	16	43,486	3,928

"It will be seen," continues the report, "from the foregoing particulars that commercial operations on the experimental line commenced on February 6th, 1902, therefore the period of maintenance commenced on April 17th, 1902, and terminates on April 17th, 1903."

Mr. Shawfield then goes on to say that he has prepard a full report of the working of the system up to February 28th, 1903, in order that the Tramway Committee and the Council may have ample time in which to fully discuss the question and to make arrangements for the construction and equipment of such further routes as it may be considered advisable to proceed with during the forthcoming summer.

He states, however, that he has not dealt with the question of the life of the granite boxes and the paving round them. That point, as a matter of fact, is treated separately by the borough surveyor (Mr. Geo. Green). Mr. Shawfield points out that every incident in connection with the working of the system has been carefully noted by means of daily records, and that a constant series of experiments have been carried out in order to elucidate any points which were at all obscure or doubtful.

Then follow the terms of the contract with the Lorain Steel Co, the main points of which are that the Corporation should take the system over should it prove a commercial success; the contractors to remove the system in the event of failure to prove a commercial success; whilst Clause 17 is to the following effect:—

> If the contractors shall neglect to proceed with the removal of the feeder pillars and contact boxes and reinstate the paving as detailed in Articles 9 and 16 of these conditions within one month of the receipt of notice to that effect from the Corporation, the Corporation may themselves effect such removal and reinstatement, and may charge the cost of the same to the contractors.

It is provided that disputes shall be settled by arbitration.

Mr. Shawfield next deals with five points:—

1. Safety to human beings and animals.
2. Reliability.
3. Consumption of electrical energy per car-mile.
4. Cost of working.
5. Cost of maintenance.

As to the first point Mr. Shawfield states that the possible sources of danger are two:—

(*a*) Obstruction to traffic due to the projection of the metal contact plates above the street surface;

(*b*) Risk of electric shock to human beings or animals from defective boxes.

As to the obstruction to traffic, the electrical engineer states that the fact that there is no record of any accident having been reported is in itself reasonable evidence that this source of danger is more apparent than real.

As to the possible injury from shock, Mr. Shawfield says that this is probably one of the most important questions which has to be considered in connection with the system, as it is in this respect that the great majority of other surface contact systems have proved defective. He does not think it feasible to devise or construct a surface contact system in which there is absolutely no possibility of a stud being "alive" except when a car runs over it, and he states it is a matter of common knowledge that cases have occurred in Wolverhampton where boxes have been found "alive," and incidents are on record of persons and animals having received shocks therefrom. Continuing, he asserts it is equally well known that it is by no means an infrequent occurrence for accidents to occur in connection with the overhead system through telephone and telegraph wires falling on the trolley wire and coming into contact with human beings and animals, with serious and sometimes fatal results.

The question to be settled, therefore, is, Does the Lorain surface contact system present greater or less risk of electric shock to users of the streets than the overhead system, and is the shock from a surface contact stud more or less dangerous than that received from a fallen trolley wire or a live telephone wire?

Mr. Shawfield has carefully analysed the daily records, and gives a table, which is highly technical in character, showing cups damaged in fixing, leakage, and so forth from May to February. The large percentage of live studs found during May was entirely due to insufficient care being taken in the assembling of the various parts of the boxes before fixing, and to the general haste with which the work was done in order to get the line open in time for the Exhibition. Since June, 1902, Mr. Shawfield says that practically every live stud found on the line was due to damage done to the cup by heavy short circuits caused by scrap-iron on the track, and as these short circuits, with few exceptions, only occurred at points and crossings, it follows that the principal risk from live studs is also at such points and crossings. It was very rarely that a case occurred of a box being alive at a dangerous voltage other than at certain known places.

Another table is given containing details of cases of electric shock. These include horses; while under date May 24th drivers received shocks when assisting horses, but "were more startled than hurt."

Mr. Shawfield makes comparisons as to other towns where the overhead system is in operation, with a view to obtaining information as to risk of shock, Sunderland, Bolton and Liverpool (which he has visited) being quoted. At Sunderland the number of emergency calls per mile per annum of single track was 4·07; at Bolton 3·54; at Liverpool 10·15.

"I am of opinion," adds Mr. Shawfield, "that a careful consideration of the foregoing facts justifies the conclusion that although with the Lorain system there is probably a somewhat greater liability as to shock, there is distinctly less injury to users of the streets."

Coming to the question of liability, a comparative table is given covering a period from May, 1902, to February, 1903. This shows that 376,600 car-miles were run, and that from all causes 1,483 miles were lost. In a section showing the miles lost in consequence of faults in the Lorain system the totals are:—Lorain car equipment, 595; ditto track equipment, 85; total 680. The proportion of car-miles lost due to the Lorain system, to total car-miles run, was, the report states, much greater during May, June and July. This is accounted for by the fact that during those three months all available cars were kept in service. Consequently there were no spare cars at the depôt, so that in the event of a mishap to any one of the cars in service, that car had to remain at the depôt until repairs were effected. Mr. Shawfield considers that the more correct method of calculating the percentage of journeys lost, due to defects in the Lorain system, is to take the figures shown from August to February inclusive, during which time the full complement of cars was available. For that period the car-miles lost averaged 5·2 miles per mile of single track per month, or 62 car-miles per mile of single track per annum, a percentage of ·13 per cent. He does not find under this head that similar systematic records have been kept of other systems.

Dealing with the consumption of electrical energy per car-mile, the report states that assuming the average cost paid for electrical energy in the future will be 1·65d. per unit, the additional cost in electrical energy consumed by the Lorain system will be ·41d. per car-mile. As regards the cost of working, Mr. Shawfield says it is obvious that the figures obtained from the first year's operation could not in themselves be regarded as a satisfactory and reliable basis, but consideration must necessarily be given to expenses which would have to be incurred in future years through renewals which have not been necessary during the first year's operation.

In considering the comparative costs of maintenance of the Lorain and overhead systems it should be pointed out (says Mr. Shawfield) that the estimated cost of maintenance for the Lorain system takes into account all renewals which are likely to be necessary over a considerable period, and therefore account should be taken of similar renewals in the case of the overhead system over and above the ordinary annual cost of repairs. "It is very difficult to say just what these renewals would amount to if the overhead system were installed in Wolverhampton, as a good deal naturally depends on the type of overhead construction adopted, but I do not think that £20 per mile of single track per annum is in any way an excessive estimate. On the same basis of car-mileage per mile of single track that has been assumed in the case of the Lorain system this is equivalent to ·1d. per car-mile."

Mr. Shawfield makes some important statements on wear and tear of contact plates. He says that, from careful observations of the average rate of wear and tear of these plates, he is of opinion that the average life will be about two years. On this basis the annual cost of renewals will be very heavy indeed, as, when a certain depth of metal is worn away from the centre part of the contact plate, the whole plate has to be scrapped, and a new plate fixed.

Mr. Shawfield says that on several occasions he had drawn the attention of the Lorain Steel Co. to the heavy annual expenditure which would have to be incurred in the renewal of contact plates if the present form of plate were adopted, and they have now brought out an improved form of plate in which the centre position, which is subject to wear, is made removable, so that it can be taken out and replaced whilst the cars are running. The average depth of metal which can be worn away before renewal was necessary was about 30 per cent. greater than with the existing type of contact plate, so that the average life will be increased. With the present form of contact plate the number of renewals per annum might be taken as 275 new contact plates per mile of single track, to which should be added five plates per mile of single track, for replacements at stopping places where the wear is very much more rapid, making a total of 280 new contact plates per mile of single track per annum, the cost of which, including labour, would be £224, or 1·12d. per car-mile.

With the improved form of contact plate, Mr. Shawfield estimates that the average life will be three years, and consequently that renewals will be 183 per mile of single track per annum. Adding five in respect of special renewals at stopping places, there will be a total number of 188 renewable centres required per mile of single track, which, including labour in fixing, represents an annual expenditure of £19, or ·094d. per car-mile.

He considers that the existing type of contact plate cannot be considered satisfactory within the true intent and meaning of the contract, and that consequently the contractors are bound to replace at their own expense the whole of the existing contact plates as a necessary condition to the acceptance of the system. Providing the existing contact plates were replaced by others of the renewable type, then the lower of the two figures previously mentioned might be taken as the probable annual cost of maintenance.

A comparative table giving the costs of the two systems is

included in the report, the statement being worked out at cost in pence per car-mile. For the Lorain the total given is 4·135d. and and for the overhead system 2·296d. The extra annual expenditure, it is stated, if the Lorain system be adopted, will be approximately as follows:—

	Cost at 1·889d. per car-mile.		Cost at ·818d. per car-mile.
On routes at present in operation ...	£4,088	or	£1,807
On remainder of routes scheduled in Parliamentary plans	5,440	or	2,405
	£9,528	or	£4,212

The first total refers to the plates at present in use, and the second is the amount should the new one be adopted.

The above figures, proceeds the report, "do not include any allowance for interest and sinking fund on the extra capital expenditure that will be incurred with the Lorain system, as it is expressly stipulated in Clause 19 of the contract that no regard is to be taken in respect of interest on capital and sinking fund. For the information of the committee, however, I may state that the extra capital expenditure on the Lorain system, including both track equipment and car equipment, may be taken as £1,250 per mile of single track, the interest and sinking fund on which, calculated at 4 66 per cent., amounts to £58 per mile of single track per annum."

It is estimated that the total annual expenditure in interest and sinking fund on mileage already constructed will be £696, and on the remainder of the routes £754, a total of £1,450.

In his conclusions the engineer states that the responsibility which has devolved upon him of having to give a definite opinion from an engineering standpoint as to the success or failure of a system of electrical traction which has only been in commercial operation for one year is very heavy, especially as circumstances require that he should give an estimate of the future annual cost of operation for purposes of comparison with another system which has been running for many years, and the operating costs of which are more or less standardised. The responsibility for deciding whether or not the advantages offered by the Lorain surface contact system are commensurate with the extra expense involved rests upon the Tramways Committee and the Council.

Accompanying Mr. Shawfield's report is a statement by Mr. Geo. Green, the borough surveyor, who deals with such questions as paving, and the system so far as it affects the roads, details being given as to wear and tear. He also presents a table showing the condition of the granite castings belonging to the boxes from the time of their fixing to the present date.

THE PRESENT POSITION OF THE ALUMINIUM INDUSTRY.

By JOHN B. C. KERSHAW, F.I.C.

(*Concluded from page 472.*)

II.—Utilisation.

The use of aluminium for overhead electrical conductors continues to expand in America. In Europe there is less readiness to try aluminium as a substitute for copper, and outside the producing works there are comparatively few instances in which the new metal has been employed for conducting purposes. This attitude of distrust is due to the unsatisfactory results obtained in some of the early trials with aluminium wire in Europe, and also to the greater demand for durability in European installations for power transmission. The American craze for "scrapping" plant and machinery every few years has not yet become popular in Europe.

As regards recent use of aluminium for bare overhead lines in America, the Lewiston and Auburn Electric Co., the Boston and Maine Railroad Co., the Boston Electric Light Co., and the Massachussetts Electric Co. have all placed large orders for aluminium wire or cable with the Pittsburg Reduction Co. during 1902. The transmission line which is now in course of erection between Shawinigan Falls and Montreal is also of aluminium, seven strands of No. 6 wire being employed for the cable. Reports which have been published during 1902 in American papers relating to the condition of overhead lines of aluminium erected in 1899, 1900 and 1901 give satisfactory accounts of these. Most of these lines are, however, on the Pacific Coast, where the climate is more favourable to the durability of the new metal than in the Eastern States or in Europe.

The writer believes that the different experiences of various observers upon the resistance of aluminium to exposure, is partly due to this difference in climate. It is evident that even Americans are beginning to recognise that aluminium is not absolutely resistant to weather influences under all conditions of exposure. At Shawinigan Falls the aluminium conductor is enclosed by a wooden erection, and it is stated in the *Aluminium World* of May, 1902, that "*weather-proof* aluminium wire is being largely introduced in the distributing systems of many of the cities in California and Washington." In the United Kingdom the Post Office authorities are apparently not inclined to experiment further with aluminium wire for telephone or telegraph purposes. Mr. J. Gavey, Engineer-in-Chief to the Post Office, has informed the writer that the trials made in Staffordshire in 1900-1901 have not been continued, and that there is no intention at present to institute a new series of experiments.

In motor-car construction work, the alloys of aluminium would appear to have a promising future, and it will not be surprising if in time the manufacture of these alloys should become a flourishing sub-branch of the aluminium industry. In America, the Winton Co., of Cleveland, are stated to be using the new metal, and Messrs. J. M. Quinby & Co., of Newark, are reported to have built a 16-H.P. automobile of the Panhard type with the body of the vehicle entirely of aluminium. At the Paris (1902) Exhibition of Cycles and Automobiles, Charpentier & Cie, of Valdois, had an exhibit of aluminium which attracted much attention. Sheets and ornamental panels of strengthened aluminium (aluminium renforcée) were the chief novelties of this exhibit. One French firm of autocar builders has also tried the new metal for the wheels, while the firm of Charron, Girardot & Voigt is reported to be using aluminium and its alloy, partinium, largely in construction work.

Builders of automobiles will, however, have to recognise that aluminium and its alloys are not absolutely non-corrosive under all weather conditions; and they will be well advised if they cover all exposed surfaces with some protective varnish.

The use of aluminium plates as a substitute for zinc, or in place of stone for lithographic work, is rapidly extending, and both in London and New York companies have been formed for the manufacture of the special rotary printing presses designed for carrying out this new departure in lithography. The English company is registered as "The Aluminium Rotary Press, Ltd.," and works are stated to be in course of erection at Otley, in Yorkshire. The capital of this company is £20,000. Thirty of these new rotary presses are reported to have been sold in Europe, and the list of well-known lithographic printing firms using one or more of these presses is growing in number. W. H. Smith & Co., of London, De la Rue & Sons, of Bolton, and E. S. & A. Robinson, of Bristol, are some of the more important English lithographic printing firms who have started during 1902 to use the new metal. The first-named firm have informed the writer that they find aluminium an excellent substitute for stone, and as the speed of printing in colours can be greatly increased by the use of rotary presses, aluminium is likely to find a wide field of usefulness in the colour printing industry.

For general foundry work, as an addition to iron and steel at the moment of casting, aluminium continues to be largely used, but it is difficult to obtain any reliable figures showing the consumption for this purpose. In this country the sales to the steel works are stated to be disappointing, but in France the consumption of aluminium for foundry purposes is stated to reach 400 tons per annum. The Goldschmidt process for the production of high temperatures by the use of a mixture of powdered aluminium and iron-oxide appears to be widely used, and the manufacture of "thermit" at Essen, in Germany, must be rapidly growing. "Welded" joints for tramway purposes are in many respects superior to bonded joints, and the use of "thermit" is the simplest method of obtaining the welding temperature in electric tramway construction work.

As regards the production of small toilet and ornamental articles, the manufacture of aluminium combs in America has grown into an important sub-branch of this side of the industry, and it is reported that the *daily* output of all the factories now reaches 25,000. The writer inclines to the belief that one, if not two, cyphers have crept into this

estimate by mistake, otherwise Europe, and the world generally, is threatened with a perfect avalanche of aluminium hair-combs, which, according to this estimate, are being turned out in U.S.A. at the rate of 7·75 millions per year.

The manufacture of ornamental articles and novelties of aluminium has also reached considerable proportions in America, and a large trade has been built up in aluminium ash-trays, paper-knives, boxes, and similar useful small articles, which are printed with advertisers' names, and distributed gratis by firms anxious to bring their name and goods before the buying public in some novel way. This branch of the aluminium manufacturing industry is one in which capital, push and energy might be used with advantage on our own side of the Atlantic. At present this method of advertising is only employed to a very limited extent in this country.

Aluminium is increasingly employed by opticians in the form of the patent alloy "magnalium." This alloy is composed of aluminium and magnesium, and its specific gravity is 2·52. Being harder than pure aluminium, it is more suited for milling and for screw-cutting purposes.

Properties.—With regard to new observations upon the properties of aluminium and its alloys, Prof. Wilson has carried out some exposure tests with the latter in London in 1901-02, and has recorded the results obtained in a paper read before the British Association at Belfast in September, 1902. The specimens exposed were in the form of wire ·126 in. in diameter, and the exposure lasted 13 months. Corrosion was found to increase with the percentage of copper. Nickel or iron alloyed with the copper had the effect of increasing the conductivity of the wire after exposure. Prof. Wilson concluded from these observations that copper ought not to be alloyed with aluminium alone, in the preparation of light aluminium alloys which were to be submitted to atmospheric influences.

As regards the use of equal percentages of nickel and copper, the presence of these in the alloy reduced its electrical conductivity, but against this was to be set the gain in mechanical and resistant properties.

Mr. Alfred Chatterton, of the Madras School of Art, has also published some remarks on this subject during 1902; and has stated that the presence of small amounts of iron as an impurity, has serious effects upon the resistance offered by aluminium to corrosive action, even when the metal is employed simply for culinary vessels. The maximum limit of impurity allowed by this authority is ·10 per cent. Fe.

There is, no doubt, that this fact has not been sufficiently recognised by the producers of aluminium in the past, and some of the unsatisfactory results obtained with the new metal have, no doubt, been caused by the presence of excessive amounts of iron or other impurity.

Messrs. Haber & Geipert have shown in a recent research, details of which were published in the *Zeits. f. Elektrochemie* of January 2nd and 9th, 1902, that remarkably pure metal can be obtained by the electrolytic reduction process, when sufficient care is given to the preparation of the raw materials used.

The producers of aluminium in Europe and America are now fully aware of the importance of this question, and great attention is given to the preparation of the alumina and of the carbon electrodes used in the baths.

The exposure tests with aluminium and other wires which the writer commenced in 1899 have been continued during 1902. No sample of aluminium rod or wire has yet been obtained which will stand 12 months' exposure in the comparatively good atmosphere of Waterloo without corrosion. Details of these investigations upon aluminium rod and wire under exposure, extending over three years, will be published in the form of a paper during the present year.

THE LOCAL GOVERNMENT BOARD AND MUNICIPAL ENTERPRISE.

In the case of East Barnet Valley, it is satisfactory to find the Local Government Board recognising the principle of consulting the ratepayers before committing them to the risk of what appears to be a very unnecessary speculation. This action completely reverses the course adopted by the department in the case of Tonbridge about two years ago. Then, it will be remembered, there was not only a division of opinion on the Council, but a test poll of the ratepayers, with a result which proved their practical unanimity in opposition to this scheme. This was followed by an election of Councillors, when the test question was the electric lighting scheme, and here, again, the decision was against the scheme; but in spite of all this the loan was sanctioned.

As we pointed out at the time (Electrical Review, August 2nd, 1901), the ratepayers ought to have the opportunity of deciding the question by a poll before any application for a loan is made; and in any further alteration in the Electric Lighting Acts, this procedure should be provided for as a *sine quâ non* before any steps are taken for obtaining sanction to borrow capital for such undertakings.

Whether or not a referendum to the ratepayers should be made as a condition before the grant of a provisional order by the Board of Trade to a local authority, is also worthy of consideration. In many cases the order is taken with a view to delay, or to give the municipality a control over the undertaking, even if worked by a company, but since the elimination of the transfer clause, the position of the municipal undertaker is rendered more difficult, as the only means of evading the working of the order is by a contract under the eleventh section of the Act, and this does not relieve the local authority from the responsibilities of undertakers until a new order is obtained by the contractors, which secures in a roundabout way the actual transfer of the powers.

The case of East Barnet Valley is a strong one, as the memorial referred to in the letter from the Local Government Board to the honorary secretary of the opposing Ratepayers' Committee contained the signatures of so large a body of ratepayers, that in face of such a document it is surprising that a mere moiety of the Urban District Council persevered with their application.

But apart from the disinclination of the residents to sanction the scheme, the circumstances of the case render any such speculative undertaking at their risk absolutely unnecessary, for the mains of the company supplying the adjacent district of High Barnet are actually laid to the boundary of East Barnet Valley both at New Barnet and Hadley Wood, and as appears from a letter addressed to a local contemporary by the company, by merely extending the mains, both the compulsory area and the important residential district of Hadley Wood can be supplied on considerably lower terms than the engineer of the Council estimates as needed by the municipal scheme, viz., at a general average to the private consumer of 3¼d. per unit, instead of 7d., besides supplying over a much larger area. Under such circumstances it is not surprising that for the forthcoming election candidates have declared strongly against the scheme.

The legitimate work of the municipalities involves such large financial obligations, that the question of ways and means is causing anxiety in many districts.

In the programme for the annual meeting of the Association of Municipal Corporations there are some items of significant interest, to wit:—

A representative of Battersea to move:—"That the Association assist the Metropolitan Borough Councils to obtain legislation giving power to Metropolitan Councils to issue stock to defray the cost of remunerative schemes." And again—

A representative of Battersea "to submit a list of items of expenditure in that Council's accounts to which the Local Government Board auditor has taken exception," and to move:—

"That the Association assist the Metropolitan Borough Councils in obtaining an amendment of the law so as to give to Metropolitan Councils greater discretionary powers of expenditure!"

The borough of Battersea, under the guidance of John Burns, M.P., may rank as the headquarters of the Municipal Socialist party, and if the representative in question voices the opinions of the Corporation, it appears as if the desire is to keep accounts, raise and spend money without control, no doubt for the purpose of enabling their chief to carry

into effect his cherished policy of municipalising all trade, nd abolishing private enterprise.

It will be interesting to know what the differences of opinion are between the Local Government Board auditor and the Corporation. The electric lighting accounts for the year ending March 31st, 1902, have been issued, and we can imagine some points upon which the auditor may be inquisitive.

The start in working their electricity supply undertaking will not entitle it to be ranked as a "remunerative scheme," but "Hope springs eternal in the human breast," and doubtless the municipalist will exclaim with the immortal Sam Weller, "It's all werry capital."

£155,122 5s. 6d. has been spent, involving an annual charge for interest and sinking fund, say, at 6 per cent. of £9,307; add to this 3 per cent. for obsolescence, depreciation and other contingencies, and the total to be provided for upon present expenditure is £13,960 per annum.

According to the revenue accounts the payments have exceeded the receipts by £40 0s. 4d., and there is an adverse balance in the net revenue of £9,012 15s. 7d., which is carried forward. No charge upon the rates appears to have been made to meet this deficiency, but cash due to the treasurer of £12,571 0s. 9d. supplies the omission. There is no provision for depreciation, and the sum charged for interest and sinking fund only amounts to £3,809 6s. 7d.

No wonder that the representative of Battersea seeks help from the Association of Municipal Corporations and hoists signals of distress!

NEW PATENTS APPLIED FOR, 1903.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

6,651. "A new or improved electrically-driven appliance for cleaning windows, walls, and other surfaces." H. Partington. March 22rd.

6,660. "Improved cradle or support for the receiver or hand set of combined table and wall telephones." B. Brander. March 23rd.

6,671. "Improvements in or relating to telephonic and signalling apparatus." J. Higginbottom. March 23rd.

6,680. "Improvements in switching apparatus for use at junction of slots in conduit tramways, electrical or mechanical." D. McGregor Stewart. March 23rd.

6,718. "Improvements in controllers for electric circuits." T. von Zweigbergk. March 23rd.

6,719. "Automatic controller for electric circuits." T. von Zweigbergk. March 23rd.

6,740. "Method and apparatus for photographically recording characters in printing telegraphs." Siemens Bros. & Co., Ltd. (Siemens & Halske, Aktien-Gesellschaft, Germany.) March 23rd. (Complete.)

6,741. "Improvements in telephonic exchanges." Siemens Bros. & Co., Ltd. (Siemens & Halske, Aktien-Gesellschaft, Germany.) March 23rd. (Complete.)

6,742. "Method and apparatus for telegraphically recording type-written characters." Siemens Bros. & Co., Ltd. (Siemens & Halske, Aktien-Gesellschaft, Germany.) March 23rd. (Complete.)

6,792. "Improvements in electric interrupters." G. B. Batten. March 24th.

6,832. "Improvements in electrical measuring instruments." T. W. Varley. March 24th. (Complete.)

6,853. "Improvements in electric road carriages and similar vehicles." E. Draulette. March 24th.

6,878. "Improvements in or connected with insulators for electrical conductors." A. Bries. March 25th.

6,887. "Improvements in means for operating the switches and points of electric railways and tramways." J. Morgan. March 25th.

6,892. "Rail bond for electric tramways and light railways." I. V. Zealander and M. Cummins. March 25th.

6,911. "Improvements in adjustable electric light pendants or fittings." H. McGowan. March 25th. (Complete.)

6,926. "Improvements relating to electric telegraphy." A. Muirhead. March 25th.

6,928. "Improvements in electric meters." E. A. Carolan. (The General Electric Co., United States.) March 25th.

6,951. "Improvements in alternating electrical current meters." A. G. Bloxam. (Luxsche Industriewerke, A. G., Germany.) March 25th.

6,952. "Improvements in electric igniters for internal combustion engines." G. A. Goodson. March 25th. (Complete.)

6,953. "Improvements in electric igniters for internal combustion engines." G. A. Goodson. March 25th. (Complete.)

6,954. "Improvements in forming lead peroxide on plates of electric accumulators." J. Diamant. March 25th.

6,958. "An improvement relating to dynamo-electric generators and motors." J. D. R. Blain. March 26th.

6,968. "A form of electric lamp." A. R. Upward. March 26th.

6,977. "Improvements in or connected with the trolley wheels used in overhead electric traction." G. W. Shepherd. March 26th.

6,998. "Improvements in the manufacture of stranded electrical conductors." E. A. Claremont and J. Stratton. March 26th.

7,022. "Means for varying the self-induction coils, and the application thereof to the measurement of the velocity of bodies in motion." J. Y. Johnson. (The Elektrizitäts Actien Gesellschaft vormals W. Lahmeyer & Co., Germany.) March 26th.

7,026. "Apparatus for detecting whether railway or like points are in their correct position, and an electrical switch for use therewith." Siemens Bros. and Co., Ltd., and L. M. G. Ferreira. March 26th.

7,071. "Improvements in and connected with electric ignition devices as applied to internal combustion engines." W. B. Burchall. March 27th.

7,079. "Improvements in stationary signals for indicating the stopping places of electric tramcars and the like." T. Coleby. March 27th.

7,107. "Electric drill." R. Breach. March 27th. (Complete.)

7,133. "Improvements in secondary batteries." S. Basch. March 27th.

7,135. "Improvements in devices for suspending overhead electric conductors." E. A. Carolan. (The General Electric Co., United States.) March 27th.

7,136. "Improvements in globe holders." E. A. Carolan. (The General Electric Co., United States.) March 27th.

7,137. "Improvements in selective transmitting systems." E. A. Carolan. (The General Electric Co., United States.) March 27th.

7,138. "Improvements in method of and means for protecting electrical apparatus." E. A. Carolan. (The General Electric Co., United States.) March 27th.

7,139. "Improvements in alternating electric current motors." E. A. Carolan. (The General Electric Co., United States.) March 27th.

7,140. "Improvements in electric railway apparatus." E. A. Carolan. (The General Electric Co., United States.) March 27th.

7,141. "Improvements in alternating electric current motors." E. A. Carolan. (The General Electric Co., United States.) March 27th.

7,142. "Improvements in electric metering systems." E. A. Carolan. (The General Electric Co., United States.) March 27th.

7,184. "Improvements in and relating to switching devices for intercommunication telephones." E. L. Joseph and G. Gardner. March 27th. (Complete.)

7,221. "Improved means for electrically stopping the pendulum of a metronome (or the like) for recording accuracy in the measurement of time." P. Harris & Co., Ltd., and S. Belcher. March 28th.

7,241. "An improved loose handle and quick brake combined switch and fuse." S. Whipp. March 28th.

7,263. "Improvements in electric ignition apparatus for internal combustion engines." W. Geipel, F. M. T. Lange, and H. G. Such. March 28th.

7,286. "An improved holder for electric light shades." H. Simmonds. March 28th.

7,293. "Method of regulation for alternate current machines." G. Winter and F. Eichberg. March 28th.

PUBLISHED SPECIFICATIONS, 1902.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

173. "Improvements in and relating to electric lighting arrangements particularly applicable for railway trains." F. W. Schneider. Dated January 2nd.

351. "Improvements in connection with electrical bells, telephones, ringing keys, contacts, switches, indicators, relays, and the like." J. H. Parsons. Dated January 6th.

365. "Improvements in magnetic separators." A. E. Salwen. Dated January 6th.

750. "Improvements in wireless telegraphy." S. G. Brown. Dated January 10th.

887. "Improvements in electrically-actuated devices for locking the doors of tramway, railway and like vehicles." M. Fees, R. Zwack, W. Fuhrmann and L. Kottmair. Dated January 11th.

1,021. "Improvements in electric switches." W. H. Chipperfield and E. S. Cook. Dated January 14th.

1,238. "Improved collector for electrical machines." The British Westinghouse Electric and Manufacturing Co., Ltd. Dated January 16th.

1,239. "Improvements in telegraphs." W. D. Kilroy. Dated January 16th.

1,251. "Improvements in and relating to electricity meters." W. M. Mordey and G. C. Fricker. Dated January 16th.

1,313. "Improvements in and relating to surface contact systems for electric traction." H. Rast. Dated January 17th.

1,772. "Improvements relating to telephone systems." E. P. Baird. Dated January 22nd.

1,874. "Improvements in controllers for electric motors." T. S. Perkins. Dated January 23rd.

1,967. "Improvements in the manufacture of electric cables for telegraphic and telephonic purposes." H. W. Dover. Dated January 24th.

2,024. "Improvements in collectors for electrically-propelled vehicles." A. Hill. Dated January 25th.

2,125. "Improved electric measuring apparatus with movable spools." Dr. R. Franke. Dated January 27th.

2,352. "Improvements in automatic means for breaking electric circuits." J. Ferguson and Kelvin & James White, Ltd. Dated January 29th.

2,363. "Improvements in and relating to portable accumulators." L. A. Lammerts. Dated January 29th.

2,584. "Improvements in rheostats or electrical resistances." A. B. Rigby and E. G. Scott. Dated January 31st.

2,674. "Improvements in and connected with electric meters of the thermal type." M. P. Thomsen. Dated February 1st.

2,700. "Telephone exchange circuit." G. Lambert. Dated February 3rd.

2,840. "Improvements in street lamps or lanterns for incandescent electric light" E. Stanley and The British Prism Globe Electrical Co. Dated February 3rd.

2,869. "Improvements in and relating to automatic fuse cut-outs and cutins." A. Vandam and T. H. Marsh. Dated February 4th.

2,984. "Improvements in apparatus for use in starting and controlling electric motors." A. H. Adams and J. T. Mould. Dated February 5th.

2,990. "Improvements connected with incandescent electric lamps." J. Swinburne and M. Solomon. Dated February 6th.

3,059. "Improvements in and connected with current collectors for electric vehicles." L. Lavagne and L. Bertrand. Dated February 6th.

3,063. "A double-acting arc lamp brake for the perfect feeding of the carbons at a uniform rate." F. Carter. Dated February 6th.

3,157. "Improvements in arc lamps." H. T. Harrison and The Improved Electric Glow Lamp Co., Ltd. Dated February 7th.

3,279. "Improvements in conduits for electric cables and the like." J. Place & Sons, Ltd., and W. H. Place. Dated February 10th.

3,746. "Improvements in and connected with electric ignition devices for internal combustion engines." A. F. Spooner. (J. Guenet, France.) Dated February 18th.